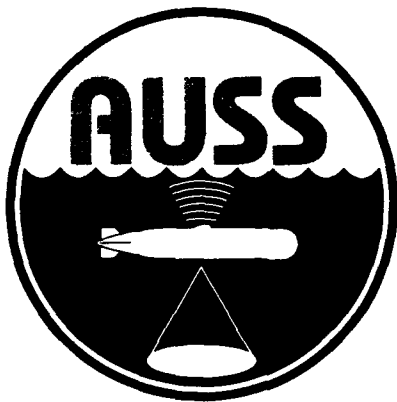


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Technical Report 1539
September 1992

Advanced Unmanned Search System (AUSS) Battery Monitor/ Charging Systems

M. E. Rasmussen

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ADMINISTRATIVE INFORMATION

The work was performed by members of the Ocean Engineering Division (Code 94), Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA 92152-5000. The work was funded under program element 0603713N, project S0397.

Further information on this subject is available in related reports that represent NRaD efforts through FY 1992. The bibliography is found at the end of this report.

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MA

SUMMARY

This report describes the Advanced Unmanned Search System (AUSS) main battery charge/discharge monitor system and its components. Also described is the emergency processor battery charger. Charging/discharging instructions for the battery monitor, a list of schematic drawings of the battery monitor and its components, and the computer programs for the battery charges and discharges are included in this report as appendices A through E.

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INTRODUCTION

This report is one of a series of reports that document the integration of several components of the Acoustic Unmanned Search System (AUSS). The AUSS is the deepest, most advanced search system being developed to date. In an attempt to make the system operate for longer periods and greater stand-off, a complex technology to put higher energy into a small package becomes necessary. The high energy of a battery can be likened to a bomb. This energy component presents a need to consider the safety of the operating personnel. Several previous battery-powered systems have caused injury and the loss of life.

The main goal of the battery monitoring system is to optimize battery life while maintaining a safe operating energy system. Since the AUSS is not a single-run event, the handling of the energy system becomes a requirement for repetitive operations. The overall design goal is to monitor the battery and initiate cell isolation during charge and discharge so that the battery can be safely charged and discharged yet optimized for extended battery life. The life cycle of a battery can be as low as 20 cycles, and the operators would need to know when cell life is over.

The AUSS system has a main vehicle battery used for propulsion, on-board computers, and sensors. An emergency processor battery is also used to power the processor that monitors and controls the systems vital to vehicle recovery.

The AUSS main battery is a Yardney-manufactured battery, Model #LR140DC-1, which is a 140-Ah cell. There are 80 such cells in 4 AUSS battery packs. Twenty cells in each pack are connected in series and the four packs are then connected in series for a total battery voltage of 120 Vdc. A battery cell functions properly between two voltage plateaus, approximately 1.9 and 1.6 volts (V). These voltage plateaus are rough indicators as to the cell's charge state. The battery life can be greatly prolonged by monitoring battery voltage during charge and discharge in order to evaluate each cell's charge state condition.

The manufacturer specification recommends that the battery cell voltage remain within the high- and low-cell limits, so that cell damage can be avoided and cell life increased. The high-voltage limit is 2.05 V and the low limit is 1.1 V. The specifications recommend that each cell be charged to the high-voltage cut-off level, 2.05 V, for a complete charge. The goal of a battery charging monitor system is to continue to charge all cells to their high-voltage limit in an effort to keep the battery as balanced as possible. The monitoring system must isolate each cell that reaches the high-voltage cut-off level, so that remaining cells can continue to charge. This is achieved by shunting a 1-ohm resistor across any cell that reaches the high-voltage limit. The resistor isolates that cell by shunting the charge current and maintaining the cell voltage below 2.05 V. This cell isolation allows the rest of the battery cells to complete their charge.

A typical charge profile is one where the charge current is set at a rate close to the highest discharge rate until one cell in the battery reaches the high cut-off level. At this time the charge current is decreased to a lower rate, until a cell reaches the high-voltage limit again. Any cell that reaches the high-voltage limit at the low-charge-current rate is considered completely charged.

The high-charge rate for the AUSS battery is 7 amperes (A) and the lower rate is 2 A. If the high-voltage limit is exceeded during the battery charge a cell can be permanently damaged, and could go into an internal short circuit condition. An internal short can create extreme heat, even to the point of starting a fire. The term "hot-short" has been given to this condition.

The AUSS emergency processor battery is a nickel cadmium battery. Each cell is a Sanyo Cadnica model KR-2800D with a nominal capacity of 2.8 Ah at a nominal voltage of 1.2 V. The emergency processor power requirement is approximately 2.8 A, and the KR-2800 battery provides approximately 1 hour of emergency processor operation should the main battery supply be removed due to a vehicle subsystem failure.

BACKGROUND

The main vehicle battery has its own monitoring system so that the individual cells can be monitored during a dive. These monitoring circuits are also used by the battery charge/discharge monitor system (BCDMS). The BCDMS has several purposes, however, the main purpose is to remove cells from the charge/discharge when they have reached either the upper or lower voltage limit. The BCDMS should also be able to change charge conditions as warranted, detect hot-shorts, measure charge current, and effect necessary changes, note when cells are not taking a charge along with the rest of the battery, and secure the charge/discharge when any hardware components associated with the monitor system are not functioning properly. Additionally, the monitor should keep a record, via data file, of the cell voltages and charge rate changes during the entire charge.

The emergency processor (EP) battery is composed of NiCad batteries as mentioned earlier, and they have the undesirable feature known as the "memory effect." This effect can limit the batteries' capacity since it "remembers" the previous discharged amount and will only charge back up to an amount equivalent to the discharge. This mentioned effect causes problems when the battery is only discharged a portion of its total ampere-hour capacity. The memory effect makes it desirable to completely discharge a NiCad battery before it is charged. This along with the desire to have a hands-off EP battery charger warranted an EP battery charger.

BATTERY CHARGE/DISCHARGE MONITOR SYSTEM

The BCDMS is made up of five subassemblies:

1. Battery packs and cell monitor boards
2. Sytron powers supplies
3. Computer and I/O board
4. Computer interface/isolation circuit board (CI/ICB)
5. Charger relay control and battery cell isolation relay boards

Figure 1 is the block diagram for these subassemblies. The interconnect diagram is labeled battery charging system interconnect diagram and is designated NRaD drawing 0128047. The interconnect diagram shows a seven-digit number for each subassembly that has an NRaD drawing number.

BATTERY PACKS AND CELL MONITOR BOARDS

The AUSS battery is made up of four 20-cell battery containers. The vehicle wiring harness connects the battery containers in series so that total battery voltage is the sum of 80-cell voltages. These battery containers are referred to as battery packs A, B, C, and D. Figure 1 illustrates how the battery packs are connected within the BCDMS. The cell monitor boards (CMBs) are located within each battery pack. The CMBs can sequentially step through each cell of the four battery containers and provide a cell voltage for the BCDMS. The schematic diagram numbers for the CMB and the cell monitor relay board are listed in appendix C.

SYTRON POWERS SUPPLIES

The Sytron power supplies can be computer-controlled for constant current. Battery packs A and B are connected in series and then connected to Sytron power supply #1, refer to NRaD drawing 0128047. Each power supply is rated for 150 V at 20 A. The low-voltage power supplies (+15, -15, and +5 volts) are shown in figure 1 and are located behind the Sytrons. These power supplies provide power to the computer interface/isolation circuit board (CI/ICB) and the charger relay control and relay/resistor boards.

COMPUTER AND INPUT/OUTPUT BOARD

The Computer subassembly controls the progress of the battery charge. It generates the reset and clock pulses required for the CMBs. The computer sequentially clocks through the battery and measures the individual cell voltages. After each sequential clock cycle, the computer checks to see if a hot-short is in progress by checking if the

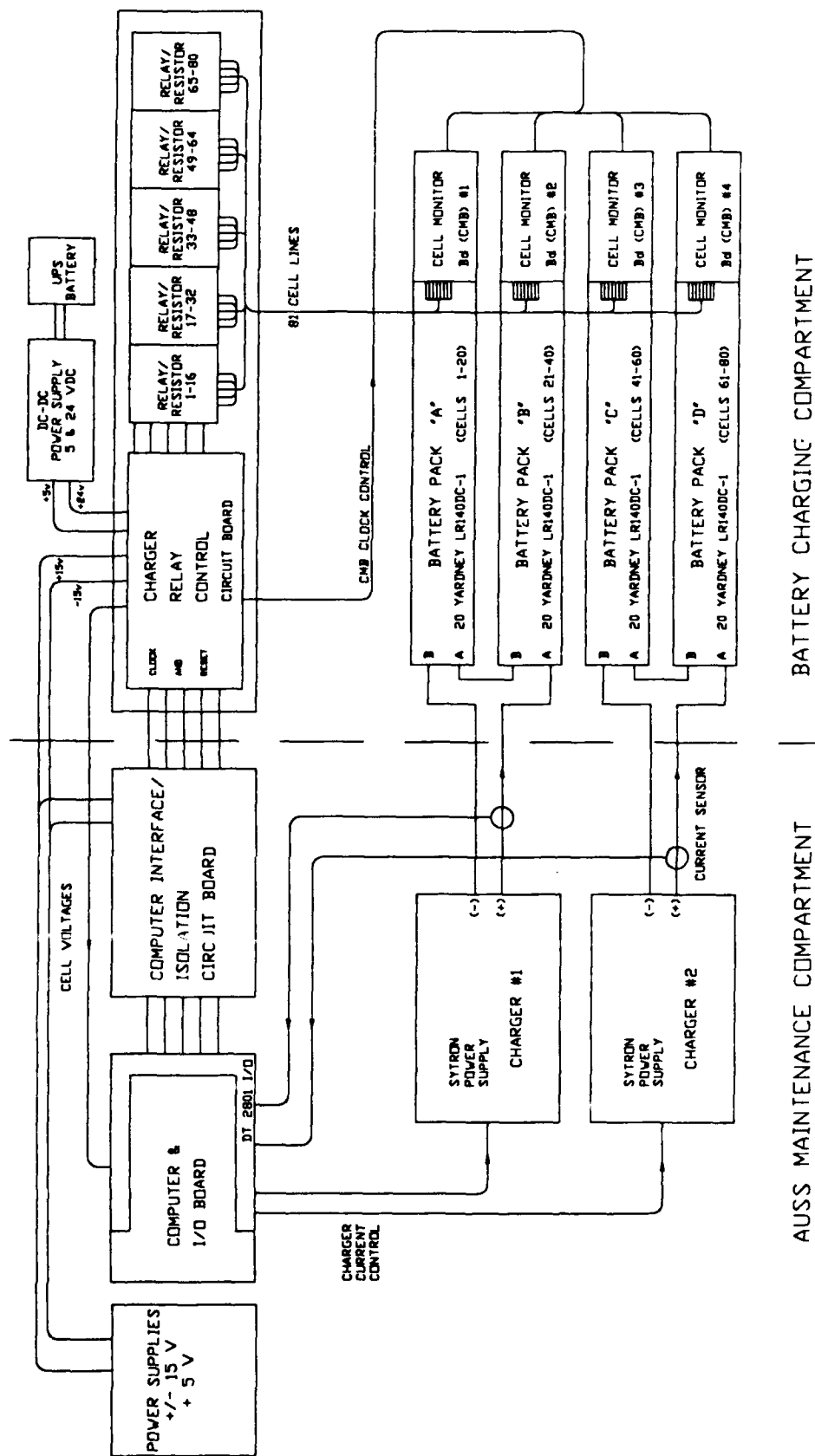


Figure 1. Battery charging system interconnect diagram.

cell voltage is less than 1.5 V. If true, the computer prints a message that the measured cell is below 1.5 V, secures that cell's charger and opens the relays affected by the current change. This condition can only exist if a cell is not taking the charge and its voltage is going in the wrong direction (down). The computer's next check is to determine if the cell has reached the high-voltage limit. When this limit is reached the program determines if that charger is at the 7-A rate or if the cell needs to be shunted with a resistor. If at the 7-A rate, the power supply affecting that cell is shifted to the 2-A rate and the relays for that bank of cells are enabled for future conditions when the cells need to be shunted by a resistor. The shunting of a cell effectively takes that cell out of the circuit. Once a cell has been shunted with a resistor its cell voltage should never exceed 2 V. If a shunted cell voltage does exceed this 2-V level, the computer secures the power supply charging that cell and opens the relays affected by that power supply's current change. The next test then determines if the measured current is the same as the commanded current. If the measured current is greater than the commanded current, the charge is secured.

These checks are made, on each subsequent cell until the entire battery has been checked. Once all 80 cells have been monitored, the high- and low-cell voltages are determined and total ampere-hours are calculated. The computer then displays the last 80-cell voltages, the high and low cells, the measured current for each charger, the total number of cells latched to a resistor, the commanded current and the actual measured current, the total ampere-hours for each charger, the sum of the cell voltages (battery voltage), and the overall average cell voltage. After 10 cycles through 80 cells, the most recent data previously displayed are recorded to the TEMP1 file on the hard disc. Other information is available to the operator as explained in the Charging and Discharging Instructions for Battery Monitor, appendices A and B respectively.

The file name of the GWBASIC program that executes these instructions is CHG.BAS. A temporary file called "TEMP1" is created during the charge and contains all pertinent charge information. After the charge is complete TEMP1 should be save through the use of PKZIP and then deleted. The next battery charge information will be appended to the previous charge if the file is not deleted.

COMPUTER INTERFACE/ISOLATION CIRCUIT BOARD (CI/ICB)

The CI/ICB circuit, refer to NRaD drawing 0127973, is used to change the control and clock signals from the computer to an RS/232 format, isolate the computer digital-to-analog (D/A) outputs from the "floating" control boards on the Sytron power supplies, and shut down the charger current and relay control current in the event computer power or low-voltage power supplies are removed.

CHARGER RELAY CONTROL AND BATTERY CELL ISOLATION RELAY CIRCUIT BOARDS

The main function of the charger relay control board (CRCB), NRaD drawing 0127970, is to energize the isolation relays located on the battery cell isolation relay printed circuit board (PCB) (NRaD drawing 0122772). The CRCB accomplishes this by converting the RS/232 signals from the computer interface circuit board to transistor-transistor logic (TTL) levels, and sequentially stepping through the cell monitor PCB (0122510), so that each cell is sampled. The CRCB provides a buffered-cell voltage to the computer for computer sampling for charge-state and cell-isolation requirements. The cell voltage is also provided to an analog-to-digital (A/D) converter on the CRCB for noncomputer-controlled charges. The CRCB can be configured for operation without a computer so that the relay latch conditions are completely controlled by the A/D and logic circuits. The CRCB has always been configured for computer control, TP2 shorted to TP3. Refer to NRaD drawing 0127970.

The CRCB energizes the appropriate relay when the charge conditions so dictate, shunting a 1-ohm resistor across an individual cell. The five battery cell isolation relay (BCIR) PCBs are interconnected as per the NRaD drawing 0127973. The BCIR PCB has 16 identical circuits, except for the relay energize control lines. The control lines are configured on each board for its location within the charger rack, refer to NRaD drawing 0122772. Five of these boards accommodate the 80 cells in the battery. The relay pins on the BCIR boards are wired to connectors ABC&D, NRaD drawing 0122772, and are connected to the individual cell lines on J2 of the cell monitor relay board, thus providing the necessary individual cell connections for relay/resistor isolation. Reset commands from the computer can open relays 1 through 40 inclusively, and/or 41 through 80 inclusively.

EMERGENCY PROCESSOR BATTERY CHARGER

The function of the EP battery charger is to completely discharge the NiCad batteries used in the EP battery packs and then automatically switch to a charge configuration. The charger should then maintain a "trickle" charge on the battery until it is reinstalled on the vehicle. The charger has three identical circuits to accommodate continuous vehicle use of EP batteries.

A partially discharged EP battery requires approximately 16 hours to be completely discharged and recharged. This means that two more EP battery packs must be available for continuous vehicle use on AUSS. See figure 2 for emergency processor battery charge/discharge time.

To operate the EP charger, connect a partially discharged EP battery to one of the three connectors on the EP charger and press the reset button nearest that connector. The EP charger then shunts the battery with a high-wattage resistor and discharges the

cell until it reaches the low-voltage cut-off level. During this time a red light-emitting diode (LED) is illuminated to indicate the discharge cycle. The EP charger then changes to a charge configuration and charges at a constant current rate (280 mA) for 15 hours. During this interval there is a yellow LED illuminated to indicate the charge is in progress. After a 15-hour timeout, the EP charger switches to a trickle rate (20 mA) to maintain a charged battery until the next vehicle installation.

The schematic diagram for the EP battery charger is NRaD drawing 0128050, emergency processor battery charger.

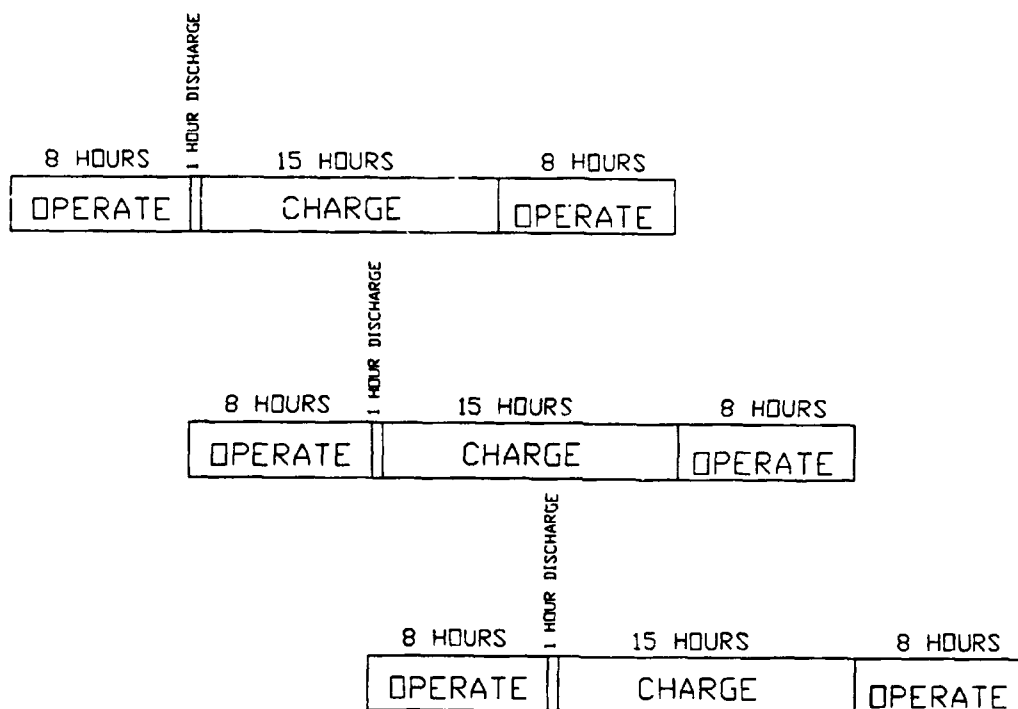


Figure 2. Emergency processor battery charge/discharge time.

LESSONS LEARNED

A new battery cell has a fixed number of cycles. A discharge followed by a charge represents one cycle. Also, once a cell has been charged by the initial "wetting" with the electrolyte, it has a limited shelf-life. It has been observed that the shelf-life of the battery is approximately 12 months, but can last longer when the battery is cycled regularly. The battery cell can withstand more cycles by avoiding exposure to voltages above or below the high- and low-cell voltage plateaus as advertised by the manufacturer. However, in a series battery cell configuration, one cell can limit the charge or discharge of the entire battery if that cell reaches the voltage limits too soon. This constitutes an unbalanced battery since all of the cells do not have the same charge state.

As mentioned in the introduction, the goal of the BCDMS is to maintain a safe operating energy system and to keep the battery balanced so as to optimize charge and discharge cycles to extend the battery life. The BCDMS is designed to isolate cells that have reached the high- or low-voltage cut-off points so that the remainder of the cells can be brought to the same charge state as the cell that had been isolated and avoid hot-shorts, which can cause fires and explosions. Due to the imperfections in cell construction the battery can still become unbalanced even after ten or more cycles where it becomes necessary to conduct an equalizer discharge and equalizer charge.

We observed through several equalizer charges that the battery appeared to balance better when the equalizer charge was preceded with an equalizer discharge. An equalizer discharge is a discharge where each cell is brought to the low-voltage cut-off by discharging the cells through the shunt resistors. Once a cell reaches its cut-off voltage, the resistor shunt circuit is opened so the remainder of the battery cells could be uniformly discharged. The equalizer discharges are followed by an equalizer charge, and the individual cells reach their respective high cut-off voltages at very nearly the same point in time, achieving a more balanced battery.

The discharge ampere-hours for three types of batteries used from March 1985 to June 1992 are shown in figures 3 through 6. The third battery was of different manufacture from the Yardney LR type. The first three batteries were 230-ampere-hour batteries. As can be seen from the plots, the 230-Ah batteries had a higher mean discharge level, but never really used the full potential rating of the battery. The fourth plot shows the history of the 140 Ah battery, which was monitored during charge and discharge by the BCDMS. The mean discharge cycle of the fourth battery was within 91 percent of the rated ampere-hour capacity for the LR 140 battery cell. The mean discharge cycles on batteries one, two and three were 37 percent, 59 percent, and 57 percent respectively. These data indicate that keeping better control on the voltage-limit levels of the cells can improve battery performance. Since the batteries have all had several cell failures at approximately 12 months, the BCDMS did not increase the life of a battery.

The manufacturer recommends when the battery is not being used for any length of time greater than 2 weeks, it was better for the battery to be in the discharged state. In the discharged state, the cells have less stress on the plates since the voltage potential is lower.

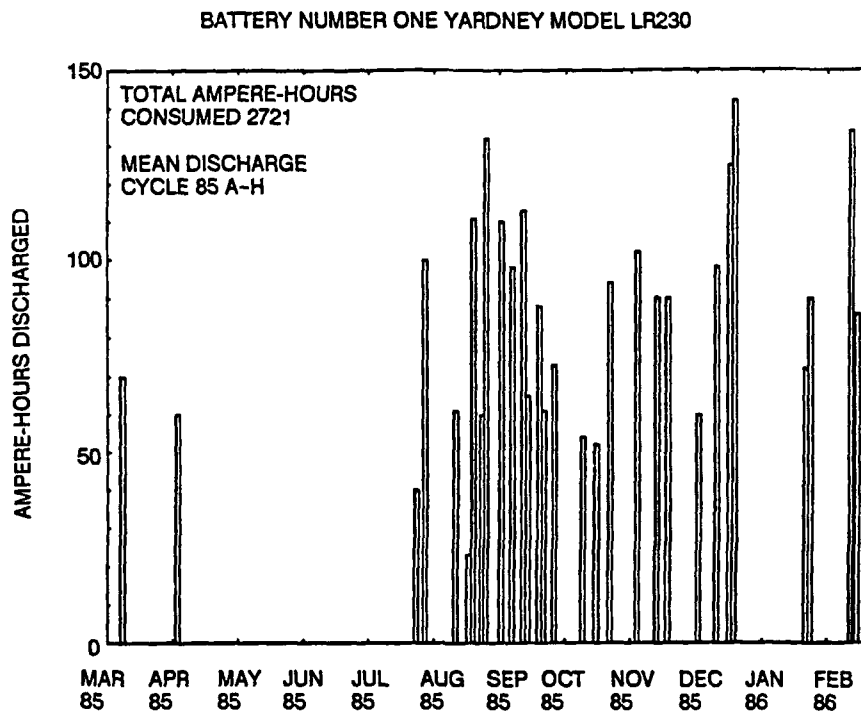


Figure 3. Battery number one Model LR230.

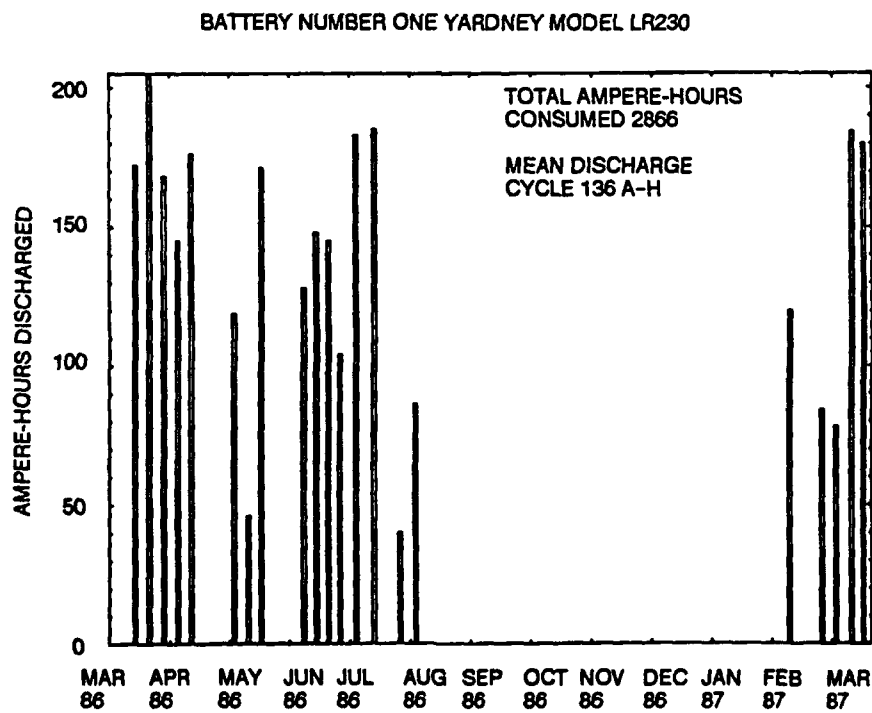


Figure 4. Battery number two Model LR230.

BATTERY NUMBER THREE BST MODEL AZL 230 DC-1

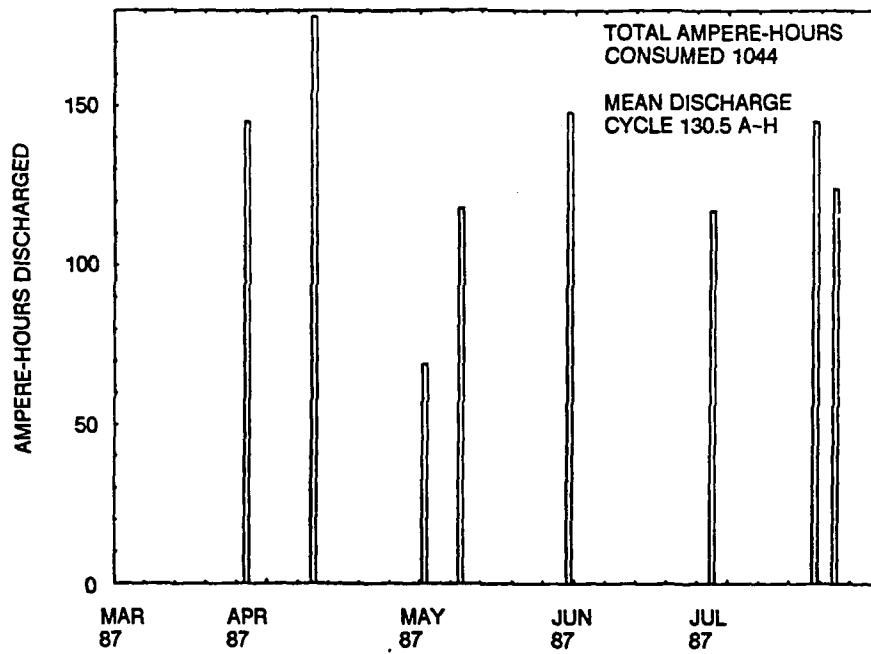


Figure 5. Battery number three Model BST230.

BATTERY NUMBER FOUR YARDNEY MODEL LR140

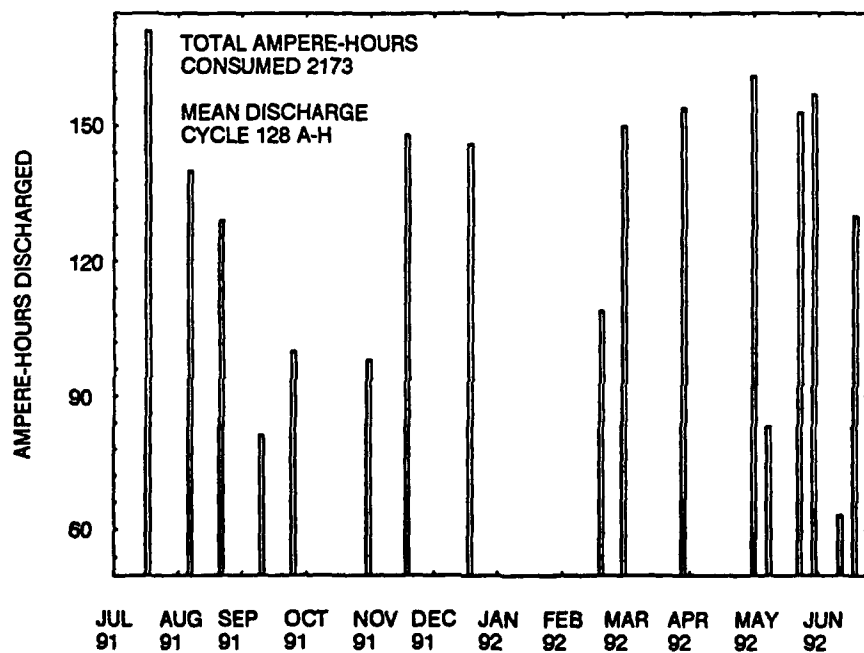


Figure 6. Battery number four Model LR140.

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APPENDIX A—CHARGING INSTRUCTIONS FOR BATTERY MONITOR

CONTENTS

I Connections

II Program Initialization And Operation

III Function Keys

IV Computer-Generated Alarms

V Securing The Battery Charge

I CONNECTIONS

The battery charging monitor system (BCMS) should be checked for proper hook-up. Disconnect the plugs that connect the cell monitor boards (CMB) to the connectors on the opposite ends of the battery boxes. Refer to AUSS drawing number 0128047, battery charging system interconnect diagram. The four cables labeled A, B, C, and D attached to the battery cell isolation relay PCBs in the battery room are connected in parallel with the CMB relay PCB plugs J2. Connect P1 through P5 on the charger relay control board for the charge configuration. AUSS drawing charger relay control board schematic (0127970) documents the electrical connections for P1 through P5 while NRaD drawing component layout relay control board (0126815) documents where the plugs are located on the charger relay control board. Next, connect charger power supply cables, plugs A, B, C, and D, to the after end of the battery packs.

Note: Once these last set of plugs are mated to the battery boxes, total battery voltage is present through the molexes behind the computer rack.

First, turn on the computer. Next, turn on the monitor power supply, located behind computer. Use the lowest mounted toggle switch located on the side of the power supply, labeled "on" toward the wall. Next, switch the relay enable (24 V) control to the up position. Then, turn on the 120 Vac for the cooling fans, also "on" is up.

The Sytron power supplies are not turned on until the charge monitoring program has been loaded and then "run" to initiate a reset to the input/output (I/O) board digital-to-analog outputs. The I/O is configured so that a -2.5 Vdc is provided to the Sytron power supplies when commanded by a reset from the computer.

II PROGRAM INITIALIZATION AND OPERATION

The BCMS program is a GWBASIC program. The computer autoexec.bat file brings the computer "up" in the GWBASIC software. The program can be loaded by hitting the F3 key after the OK prompt is displayed once the computer has "booted" into GWBASIC. Once "LOAD" is displayed, type CHG and enter. Then type "Run" and press return(ENTER). Answer questions to the prompts as necessary for the charge configuration you are selecting. Note: Once in the GWBASIC program, do not hit the return key except after answering a question by making a numerical entry. Answering "y" or "n" to any question does not require a return key entry.

The first program prompt allows the operator to reset all the outputs, setting charging power supplies to zero current, opens any latched relays, and resets counters on CMB.

The second prompt requests an input for the total ampere-hours taken out of the battery during the previous dive. The discharge ampere-hour figure is then stored on the hard disc prior to the start of a charge.

The third prompt provides the operator the option to select desired relays for closing when the selected relay is sequenced during a battery monitor scan. This is necessary when restarting a charge that has already latched out cells that have reached the high-voltage cut-off.

The final prompt is for inputting the desired charge current and charge configuration. There are four charge configurations, both chargers at either the 7-A rate or the 2-A rate, one charger at the 7-A and the other at the 2-A rate, and both chargers at the 0-A charge rate. The selection of the charge rate sets up the charging configuration within the program.

III FUNCTION KEYS

The program has soft keys as described below. They allow the operator to monitor the charge at his discretion, e.g., make a printout, look at the high and low cells, send latest charge data to the hard disc for future reference, etc.

F1: The F1 function key directs the printer to print the most recent charge information. F1 can be used as a means for establishing a hard copy of the battery charge progress. The information printed includes: the time and date, the most recent cell voltages, relay latch conditions, the average cell voltage of all 80 cells, the total battery voltage, the total charge amp-hours for both chargers, the high- and low-cell voltages for both charger packs (charger pack one [1] refers to cells 1 through 40), and the power supply current, both the measured and commanded current. See table A.1.

F2: The F2 function key displays the same information as the F1 key, but the data are displayed on the computer screen. See table A.2.

F3: The F3 function key is used to toggle the displayed individual cell information on and off. When the F3 individual cell display is off, the F2 function is displayed automatically after all 80 cells have been updated. The F3 function key on causes each cell voltage to print to the display, this is the slower sample mode. The slower mode of operation is automatically switched off when any cell reaches the high-voltage level while at the 2-A rate.

F4: The F4 function key displays the 80 relay latch conditions. A number "1" indicates that the relay has been commanded to latch a 1-ohm resistor across that cell. See table A.3.

F6: The F6 function key allows the operator to make current supply adjustments. The instantaneous current measurements are displayed, and the program then prompts the operator to enter new values if desired.

Table A.1. Information is printed to printer when F1 is pressed, and to the hard disc when F7 is pressed.

14:15:17

DATE 01-09-1992

1	1.964V	RELAY IS	NOT LATCHED	2	1.964V	RELAY IS	NOT LATCHED
3	1.964V	RELAY IS	NOT LATCHED	4	1.964V	RELAY IS	NOT LATCHED
5	1.964V	RELAY IS	NOT LATCHED	6	1.964V	RELAY IS	NOT LATCHED
7	1.964V	RELAY IS	LATCHED	8	1.964V	RELAY IS	NOT LATCHED
9	1.964V	RELAY IS	NOT LATCHED	10	1.964V	RELAY IS	NOT LATCHED
11	1.964V	RELAY IS	NOT LATCHED	12	1.964V	RELAY IS	NOT LATCHED
13	1.964V	RELAY IS	NOT LATCHED	14	1.964V	RELAY IS	LATCHED
15	1.964V	RELAY IS	NOT LATCHED	16	1.964V	RELAY IS	NOT LATCHED
17	1.964V	RELAY IS	NOT LATCHED	18	1.964V	RELAY IS	NOT LATCHED
19	1.964V	RELAY IS	NOT LATCHED	20	1.964V	RELAY IS	NOT LATCHED
21	1.964V	RELAY IS	LATCHED	22	1.964V	RELAY IS	NOT LATCHED
23	1.964V	RELAY IS	NOT LATCHED	24	1.964V	RELAY IS	NOT LATCHED
25	1.964V	RELAY IS	NOT LATCHED	26	1.964V	RELAY IS	NOT LATCHED
27	1.964V	RELAY IS	NOT LATCHED	28	1.964V	RELAY IS	LATCHED
29	1.964V	RELAY IS	NOT LATCHED	30	1.964V	RELAY IS	NOT LATCHED
31	1.964V	RELAY IS	NOT LATCHED	32	1.964V	RELAY IS	NOT LATCHED
33	1.964V	RELAY IS	NOT LATCHED	34	1.964V	RELAY IS	NOT LATCHED
35	1.964V	RELAY IS	LATCHED	36	1.964V	RELAY IS	NOT LATCHED
37	1.964V	RELAY IS	NOT LATCHED	38	1.964V	RELAY IS	NOT LATCHED
39	1.964V	RELAY IS	NOT LATCHED	40	1.964V	RELAY IS	NOT LATCHED
41	1.964V	RELAY IS	NOT LATCHED	42	1.964V	RELAY IS	LATCHED
43	1.964V	RELAY IS	NOT LATCHED	44	1.964V	RELAY IS	NOT LATCHED
45	1.964V	RELAY IS	NOT LATCHED	46	1.964V	RELAY IS	NOT LATCHED
47	1.964V	RELAY IS	NOT LATCHED	48	1.964V	RELAY IS	NOT LATCHED
49	1.964V	RELAY IS	LATCHED	50	1.964V	RELAY IS	NOT LATCHED
51	1.964V	RELAY IS	NOT LATCHED	52	1.964V	RELAY IS	NOT LATCHED
53	1.964V	RELAY IS	NOT LATCHED	54	1.964V	RELAY IS	NOT LATCHED
55	1.964V	RELAY IS	NOT LATCHED	56	1.964V	RELAY IS	LATCHED
57	1.964V	RELAY IS	NOT LATCHED	58	1.964V	RELAY IS	NOT LATCHED
59	1.964V	RELAY IS	NOT LATCHED	60	1.964V	RELAY IS	NOT LATCHED
61	1.964V	RELAY IS	NOT LATCHED	62	1.964V	RELAY IS	NOT LATCHED
63	1.964V	RELAY IS	LATCHED	64	1.964V	RELAY IS	NOT LATCHED
65	1.964V	RELAY IS	NOT LATCHED	66	1.964V	RELAY IS	NOT LATCHED
67	1.964V	RELAY IS	NOT LATCHED	68	1.964V	RELAY IS	NOT LATCHED
69	1.964V	RELAY IS	NOT LATCHED	70	1.964V	RELAY IS	LATCHED
71	1.964V	RELAY IS	NOT LATCHED	72	1.964V	RELAY IS	NOT LATCHED
73	1.964V	RELAY IS	NOT LATCHED	74	1.964V	RELAY IS	NOT LATCHED
75	1.964V	RELAY IS	NOT LATCHED	76	1.964V	RELAY IS	NOT LATCHED
77	1.964V	RELAY IS	LATCHED	78	1.964V	RELAY IS	NOT LATCHED
79	1.964V	RELAY IS	NOT LATCHED	80	1.964V	RELAY IS	NOT LATCHED

CELL AVERAGE = 1.964

TOTAL BATTERY VOLTAGE = 138.9

** TOTAL AH CHG #1 = 78.2 ** TOTAL AH CHG #2 = 76.1

HIGH CELLS ARE CELL NO.	2	1.993	AND CELL NO.	77	1.992
LOW CELLS ARE CELL NO.	23	1.903	AND CELL NO.	49	1.905

ACTUAL CURRENT

CHARGER #1 (CELLS 1 THRU 40) IS 1.99 AMPS
CHARGER #2 (CELLS 41 THRU 80) IS 6.92 AMPS

COMMANDED CURRENT

2.1 AMPS
6.9 AMPS

Table A.2. Information displayed on computer screen when function key F2 is pressed.

	1	2	3	4	5	6	7	8	9	10
1	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
11	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
21	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
31	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
41	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
51	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
61	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
71	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95

CELL AVERAGE = 0.000 ** TOTAL AH CHG #1 = 0.0 ** TOTAL AH CHG #2 = 0.0
HIGH CELLS ARE CELL NO. 0 0.000 AND CELL NO. 41 1.950
LOW CELLS ARE CELL NO. 1 1.950 AND CELL NO. 41 1.950
TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40 0 FOR CELLS 41 THRU 80 0

COMMANDED CURRENT CHARGER # 1 IS 2 AMPS CHARGER # 2 IS 2 AMPS
ACTUAL MEASURED CURRENT CHARGER # 1 2.25 AMPS CHARGER # 2 2.35 AMPS

Table A.3. F4 function key displays the 80 relay latch conditions.

' FUNCTION KEY 4 DISPLAY TO SCREEN '

RELAY LATCH CONDITITIONS (0 = OPEN 1 = CLOSED)

	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	1	0	0	0
11	0	0	0	1	0	0	0	0	0	0
21	1	0	0	0	0	0	0	1	0	0
31	0	0	0	0	1	0	0	0	0	0
41	0	1	0	0	0	0	0	0	1	0
51	0	0	0	0	0	1	0	0	0	0
61	0	0	1	0	0	0	0	0	0	1
71	0	0	0	0	0	0	1	0	0	0

F7: The F7 function key records data to a hard disc file called "TEMP1." The data are the same information sent to the printer with the F1 key. The F7 function is automatically tasked every time the program completes 10 cycles through the battery pack. This function key allows the operator to command this task at anytime, i.e., right after the first 80-cell voltages when the charge is first started or prior to securing. However, the data are not transferred to the TEMP1 file until the present 80-cell sampling sequence is completed. Four beeps are sounded when the task has been executed.

F10: The F10 function key is used to toggle the continuous tone off, if tone does not go off then the program is not running. The operator must execute the control break (CTRL-BRK) to exit the program followed by an F2(RUN) and answer the first question with a "y," resetting the chargers to zero and opening the relays.

IV COMPUTER-GENERATED ALARMS

The following list summarizes the alarms and the appropriate operator response:

***** 2 "BEEPS" *****

Under program control the computer generates two beeps after a complete battery monitoring cycle, 80 new cell values. The short moment of time between the first and second beep would be a recommended time to press F1 and send the latest data to the printer or hard disc, since the most complete and recent data are available.

***** 4 "BEEPS" *****

The computer has just sent the most recent data to the hard disc. The event can also occur whenever the F7 key is depressed during cell-voltage checks, but only after the two beeps are sounded indicating, the most recent data are available.

***** CONTINUOUS TONE *****

Several events can trigger this type of alarm. Every time this alarm is sounded the power supply affecting the cell that triggered the alarm is secured and the 40 relays that could be shunting resistors of that same group of 40 are opened. Then a message is printed indicating which cell caused the alarm, what change was made to the charge configuration, and why the alarm was initiated. Examples are

Cell voltage over 2.06 V.

Cell value over 2.00 V with the cell shunted by a 1-ohm resistor.

Cell value less than 1.30 Vdc, indicating possible hot-short during charge or cell not taking charge.

Current measures 1.0 A greater than the commanded current.

Current measures 0 A with relays enabled by the 2-A selection at the start of program. This prevents a relay from discharging a cell if the charge current stopped.

V SECURING THE BATTERY CHARGE

An emergency shutdown can be executed by turning the computer off followed by shutting off the Sytron power supplies. The power supply current should go to zero when the computer is secured.

A normal shut down sequence should include a printout and the recording of the latest data to the hard disc (Function keys F1 and F7). To complete a normal shut-down sequence, press F7 and then press F1 immediately after the first beep of the two-beep sequence. If the program is displaying individual cell voltages, toggle F3 to speed up the sample rate. Once the printout is complete and the four beeps have been heard, indicating that the "TEMP1" file was updated, execute a control break. The program is now stopped. Press F2, which restarts the program, and answer yes to the first question, setting power supplies to zero and resetting all other conditions. Then secure to the Sytrons, the monitor power supply, the fans, the 24-V relay enable switch, and finally the computer and printer.

APPENDIX B—DISCHARGING INSTRUCTIONS FOR BATTERY MONITOR

CONTENTS

I Connections

II Program Initialization And Operation

III Function Keys

IV Computer-Generated Alarms

V Securing The Battery Discharge

I CONNECTIONS

All connections should be connected according to the charging instructions for battery monitor connections.

Turn on computer. Next turn on monitor power supply located behind computer. Use the lowest mounted toggle switch located on the side of the power supply labeled "on" to starboard. Next switch the relay enable (24 V) control to the up position. Then turn on the 120 Vac for the cooling fans, also "on" is up.

The batteries are connected to four high-wattage resistors for the high-current discharge as shown in figure B.1, high-current discharge load configuration. The current can be as high as 10.5 A during this discharge configuration, so first make sure the toggle switch is in the open position. The battery will start discharging through the resistors as soon as the toggle switch is closed. The program for discharging at the high-current rate should be loaded and running when the toggle switch is closed. The toggle switch is then opened and the molex connections removed once any one of the cells have reached the low-voltage limit. This condition will be indicated by a steady tone from the computer, so the high-current-rate discharge must be monitored frequently.

The discharge is then continued using the 1-ohm resistors on the relay/resistor circuit board with the low-discharge rate program explained below. NRaD drawing 0128047, battery charging system interconnect, should be referred to for initial discharge set-up.

II PROGRAM INITIALIZATION AND OPERATION

There are two discharge programs: the high-current discharge program labeled "DISCHGH," and the low-current discharge program labeled "DISCHGL." The programs are loaded in the same manner as the "CHG" program for the charging operation. The "DISCHGH" is used to monitor the discharge while in the high-current configuration, i.e., the high-wattage resistors shunting the four battery packs. The "DISCHGL" is for monitoring the discharge while the cells are shunted by the relay/resistor circuit card, thus allowing the computer to control the progress of the discharge.

The "DISCHGH" program monitors the cells at the high-sample rate. The discharge circuit is a semifixed arrangement, so when any cell reaches the low-voltage level the computer generates a continuous tone but cannot do anything to stop the discharge. The tone alerts the operator the high-current rate needs to be secured by opening the toggle switch in the resistor load circuit. Refer again to figure B.1. It is imperative that

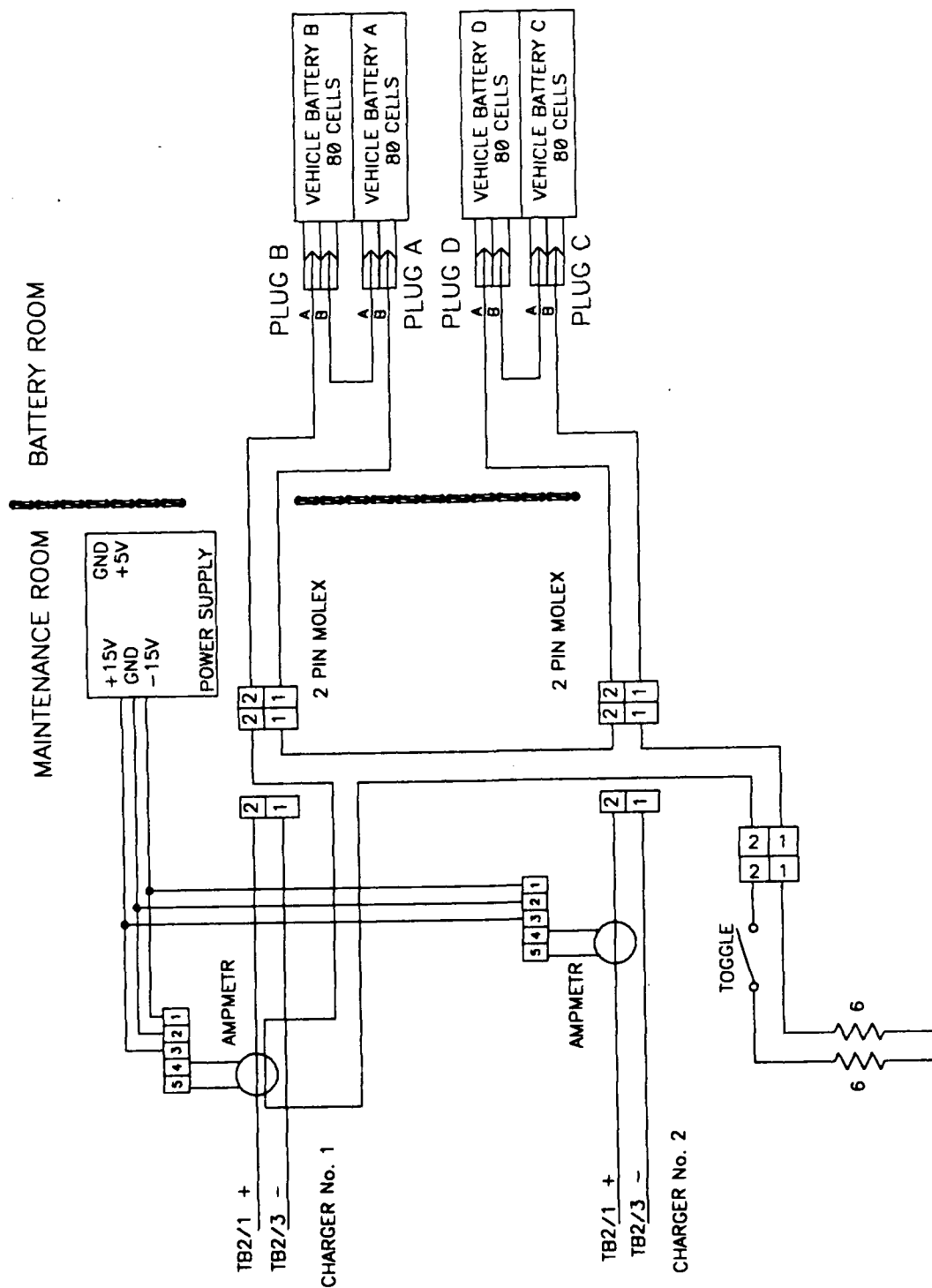


Figure B.1. High-current discharge load configuration.

the low cell, as displayed by the computer, be monitored frequently by the operator so as to note when the low cell is starting to reach the low-voltage cut-off. By anticipating the low-voltage alarm, the operator can stop the high-discharge current before cell damage can occur. The operator must then stop the program by simultaneously hitting the control and the break keys. The "DISCHGL" program is then loaded and run by typing "load dischgl" followed by a return, and then hitting the F2 key.

The "DISCHGL" program has three prompts. The first prompt asks the operator if a system reset should be initiated. An answer of yes to this question will reset the monitor clock circuits, reset all relays open, and clear all variables within the program. The next prompt is for setting up the program to shunt all cells with 1-ohm resistors. This is accomplished once the program starts running and completes a full battery cycle, 80-cell samples. The cells selected by this prompt are shunted as the monitor cycles to each cell during a normal monitoring sequence. Once the monitor completes the first 80 samples, shunting the selected cells, the computer prompts the operator as to whether the connections for relay control during discharge have been changed. Refer to NRaD drawing 0127970 for the proper plug connections for discharge. At this point the plugs P1 through P5 are changed. This configuration now allows the computer to open the relay/resistor discharge path when a cell reaches the low-voltage limit. Once the operator has changed plugs P1 through P5, he answers the prompt with a "y."

The battery cells are now being discharged at a low-current rate under the control of the computer. This continues until all 80 relays have been latched open. The battery is now completely discharged.

III FUNCTION KEYS

The function keys operate the same as the charging function keys.

IV COMPUTER-GENERATED ALARMS

The computer-generated alarms operate the same as the charging alarms except as previously noted in these instructions.

V SECURING THE BATTERY DISCHARGE

The battery discharge will be secured one cell at a time until all cells have reached the low-voltage level. The computer and power supplies will have to be secured the same as the charging procedures describe.

**APPENDIX C—AUSS SCHEMATIC DRAWINGS
ASSOCIATED WITH BATTERY CHARGE/DISCHARGE
MONITOR SYSTEM**

NRaD DRAWING NO.	DRAWING TITLE
0122510	Cell Monitor Schematic
0122513	Cell Monitor Relay Schematic
0122772	Cell Relay/Resistor Isolation Schematic
0127970	Charger Relay Control Circuit Board
0127973	Computer Interface/Isolation Circuit Board
0128047	Battery Charging System Interconnect Diagram
0128048	Cell Monitor PCBs Charging Interconnect
0128049	Vicor DC-DC Interconnect Charging System
0126815	Component Layout Relay Control Board
0128050	Emergency Processor Battery Charger

APPENDIX D—BATTERY CHARGE PROGRAM "CHG.BAS"

```

10  /***** CHG.BAS as of 3/13/92 TIME 1345 *****/
20  DEFINT A-Z ' ASSIGN ALL LETTERS AS INTEGERS
30  LC1# = 3 : LC2# = 3 ' SET LOWEST CELLS FOR #1 & #2 CHARGERS ABOVE 0
40  WIDTH "lpt1:",78
50  BASE.ADDRESS = &H2EC 'DT 2801 memory assignments
60  COMMAND.REGISTER = BASE.ADDRESS + 1
70  STATUS.REGISTER = BASE.ADDRESS + 1
80  DATA.REGISTER = BASE.ADDRESS
90  COMMAND.WAIT = &H4
100 WRITE.WAIT = &H2
110 READ.WAIT = &H5
120 CCLEAR = &H1
130 CADIN = &HC ' &H8c = ext trigger, &Hc = continuous
140 CSTOP = &HF
150 CDAOUT = &H8
160 STCHG = 0
170 DIM CV$(80) 'DIMENSION CELL VALUE (CV#)
180 DIM CEVS(80) 'DIMENSION CELL VALUE (CV#)
190 DIM CL$(80) 'DIMENSION CELL LATCH (CL#)
200 DIM COV(80) 'DIMENSION CELL OVER VOLTAGE (COV)
210 DIM Z(80) 'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
220 AS = "LATCHED"
230 BS = "NOT LATCHED"
240 CS = "CELL NUMBER "
250 DS = "V RELAY IS "
260 OUT COMMAND.REGISTER, CSTOP
270 TEMP = INP(DATA.REGISTER)
280 GOSUB 1900
290 WAIT STATUS.REGISTER, COMMAND.WAIT
300 OUT COMMAND.REGISTER, CCLEAR
310 ' ***** PROMPT TO RESET OUTPUTS AT START UP *****
320 PRINT "RESET ALL OUTPUTS? (y,n)"
330 RSTIS = INPUT$(1)
340 IF RSTIS = "y" THEN 370
350 IF RSTIS = "n" THEN 450
360 GOTO 320
370 GOSUB 2110 'set all analog and digital outputs to zero
380 ' *** PROMPT TO INPUT AMP-HOURS OUT DURING DISCHARGE ***
390 PRINT "STORE AMP-HOURS OUT OF BATTERY DURING DISCHARGE? (y,n)"
400 AHOUTS = INPUT$(1)
410 IF AHOUTS = "y" THEN GOSUB 6780 : GOTO 440
420 IF AHOUTS = "n" THEN 440
430 GOTO 380
440 ' ***** INPUT RELAY ENABLE COUNT FROM PREVIOUS RUN *****
450 PRINT "INPUT RELAY CELL NUMBER? (y,n)"
460 RSTOS = INPUT$(1)
470 IF RSTOS = "y" THEN GOSUB 6690 : GOTO 540
480 IF RSTOS = "n" THEN 540
490 GOTO 450
500 PRINT "RELAY CELL NUMBER ?"
510 INPUT CN
520 CEVS(CN) = 1
530 GOTO 420
540 ' ***** PROMPT FOR DESIRED CHARGE CURRENT *****
550 PRINT "IS CHARGE CURRENT THE SAME FOR BOTH CHARGERS?"
560 RSCGS = INPUT$(1)
570 GOSUB 6910 'SET VALUE FOR PREVIOUS TIME IN AMPHOUR CALCULATIONS
580 IF RSCGS = "y" THEN 730
590 IF RSCGS = "n" THEN GOSUB 6910 : GOTO 610
600 GOTO 550
610 PRINT "IS EITHER CHARGER AT THE 2 AMP RATE? (y,n)"
620 CHGRTS = INPUT$(1)
630 IF CHGRTS = "y" THEN 660
640 IF CHGRTS = "n" THEN 710
650 GOTO 610
660 PRINT "WHICH CHARGER IS AT THE 2 AMP RATE? ( 1 OR 2 )"
670 INPUT CHGNO
680 IF CHGNO = 1 THEN CEVL = 1 : STCHG1 = 1 : GOSUB 5430 : GOTO 840
690 IF CHGNO = 2 THEN CEVM = 1 : STCHG2 = 1 : GOSUB 5430 : GOTO 840
700 GOTO 660
710 GOSUB 5430
720 GOTO 840
730 PRINT "WHAT IS CHARGE CURRENT IN AMPS? ( TYPE 0, 2 OR 7 )" : PRINT
740 INPUT CHG.I
750 IF CHG.I = 0 THEN 790
760 IF CHG.I = 2 THEN 810
770 IF CHG.I = 7 THEN CHG.I = 100 : GOTO 830
780 GOTO 650
790 CHG.I = 0 : FS = " 0 AMP RATE " : CHG.I1# = 0 : CHG.I2# = 0
800 GOTO 840
810 CHG.I1# = 2 : CHG.I2# = 2 : FS = " 2 AMP RATE " : STCHG = 2 : CHG.I = 510 : STCHG1 = 1
: STCHG2 = 1 : GOSUB 5400 ' SRT CHGS & AM CLOCK
820 GOTO 840
830 CHG.I1# = 7 : CHG.I2# = 7 : FS = " 7 AMP RATE " : GOSUB 5400
840 ON KEY(1) GOSUB 2320 'F1 key to PRN 80 cv# & cl# to Printer
850 ON KEY(2) GOSUB 4620 'F2 key display last 80 cells to 8 rows
860 ON KEY(3) GOSUB 5130 'F3 key to toggle displayed data on/off
870 ON KEY(4) GOSUB 5800 'F4 key to display last 80 latch conditions
880 ON KEY(6) GOSUB 5430 'F6 key allows for current changes
890 ON KEY(7) GOSUB 3800 'F7 key sends data to hard disc temp1

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900 ON KEY(10) GOSUB 5940 'F10 key STOPS CONTINUOUS ALARM
910 '***** OUTPUT PULSE TO RESET COUNTERS AND MONITOR CIRCUIT *****
920 GOSUB 6120 ' GO OUTPUT RESET
930
940 '***** Loop 80 times waiting each time for the sample Pulse ***
950 TI = TI + 1
960 FOR LOOP = 1 TO 80 'start 80 samples
970 GOSUB 2250 'clock to incr monitor circuits
980 Y1 = 0 : Y2 = 0
990 SETGAIN = 2: SETCHAN = 7 'RANGE IS +/- 2.5 **** CELL.VALUE# **
1000 CVAVG# = 0
1010 FOR CVA = 1 TO 3 'AVERAGE CV# 5 TIMES
1020 GOSUB 2890 ' A/D CONVERSION FOR CV# VALUE
1030 CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
1040 CELL.VALUE# = ABS (CELL.VALUE#)
1050 CVAVG# = CVAVG# + CELL.VALUE#
1060 NEXT
1070 CELL.VALUE# = CVAVG# / 3 'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
1080 'IF LOOP = 85 THEN GOSUB 6200 : STOP
1090 GOSUB 2250 'output clock to trigger A/D on hardware
1100 IF LOOP = 19 THEN 1670
1110 IF LOOP = 20 THEN 1670
1120 IF LOOP = 39 THEN 1670
1130 IF LOOP = 40 THEN 1670
1140 IF LOOP = 59 THEN 1670
1150 IF LOOP = 60 THEN 1670
1160 IF LOOP = 79 THEN 1670
1170 IF LOOP = 80 THEN 1670
1180 IF CELL.VALUE# < 1.3 THEN FS = " CELL BELOW 1.50 VOLTS" : GOSUB 6570
1190 ' SETGAIN = 1: SETCHAN = 4 'RANGE IS +/- 5.0 **** READ CEV# ****
1200 GOSUB 2470 ' A/D CONVERSION
1210 KEY(1) ON 'enable F1 key
1220 KEY(2) ON 'enable F2 key
1230 KEY(3) ON 'enable F3 key
1240 KEY(4) ON 'enable F4 key
1250 KEY(6) ON 'enable F6 key
1260 'KEY(7) ON 'enable F7 key
1270 KEY(10) ON 'enable F10 key
1280 CEV# = (HIGH1# * 256 + LOW1#) * .0024414 - 5 'calculate CEV# value
1290 KEY(6)STOP 'DISABLE F6 UNTIL NEXT KEY ON STATEMENT
1300 CEV# = 0
1310 ' CEV# = ABS(CEV#) 'change bipolar to positive value
1320 IF CELL.VALUE# > 2.05 THEN CEV# = 5
1330 IF CEV#(LOOP) = 1 AND CELL.VALUE# > 2 THEN FS = "CELL LATCHED TO RESISTO
R AND THE VOLTAGE WAS OVER 2.0 VOLTS " : GOSUB 6570
1340 IF CEV#(LOOP) = 1 THEN GOTO 1380 'GO RETRIGGER RELAY ENABLE
1350 IF CEV# > 3 THEN 1390 ' YES, GO CHECK IF 7 AMP
1360 LCS = BS
1370 GOTO 1580
1380 LCS = AS : GOTO 1570
1390 IF STCHG < 2 THEN 1410 ' YES, GO CHECK 2 AMP RATE ON BOTH CHARGERS
1400 GOTO 1560
1410 IF LOOP > 40 THEN 1490
1420 IF CEV# = 1 THEN GOSUB 3760 : GOTO 810 'SET CHARGERS TO 2 AMPS PRINT MSG
1430 IF CEV# = 1 THEN 1560 'ALREADY AT TWO AMP RATE-GO ENABLE RELAY
1440 CHG.1# = 2:CHG.1 = 510 : GOSUB 5360 'GO OUTPUT NEW CURRENT on chg #1
1450 CEV# = 1 : STCHG1 = 1
1460 FS = "CHARGER #1 IS AT 2 AMP RATE : CHARGER #2 IS AT 7 AMP RATE"
1470 GOSUB 3480 'PRINT CHARGE RATE CHANGE TO PRINTER
1480 GOTO 1580 'RESUME CELL VALUE CHECKS
1490 IF CEV# = 1 THEN GOSUB 3760 : GOTO 810 'SET CHARGERS TO 2 AMPS PRINT MSG
1500 IF CEV# = 1 THEN 1560
1510 CHG.12# = 2:CHG.1 = 510 : GOSUB 5380 'GO OUTPUT NEW CURRENT on chg #2
1520 CEV# = 1 : STCHG2 = 1
1530 FS = "CHARGER #1 IS AT 7 AMP RATE : CHARGER #2 IS AT 2 AMP RATE"
1540 GOSUB 3480 'PRINT CHARGE RATE CHANGE
1550 GOTO 1580
1560 CEV#(LOOP) = 1 ' CELL WAS NOT LATCHED, DO IT
1570 GOSUB 3690 ' GO TRIGGER RELAY ENABLE
1580 CV#(LOOP) = CELL.VALUE#
1590 IF LOOP > 40 THEN 1630
1600 IF CV#(LOOP) > HC1# THEN GOSUB 6360 ' SET HIGH CELL 1st 40 TO CV(LOOP)
1610 IF CV#(LOOP) < LC1# THEN GOSUB 6610 ' SET LOW CELL 1st 40 TO CV(LOOP)
1620 GOTO 1650
1630 IF CV#(LOOP) > HC2# THEN GOSUB 6400 ' SET HIGH CELL 2nd 40 TO CV(LOOP)
1640 IF CV#(LOOP) < LC2# THEN GOSUB 6650 ' SET LOW CELL 2nd 40 TO CV(LOOP)
1650 IF CELL.VALUE# > 2.15 THEN GOSUB 1920
1660 IF TOGG = 0 THEN GOSUB 5190 ' GO PRINT CELL INFO TO SCREEN
1670 IF ICK > 7 THEN GOSUB 3010 : ICK = 0 : GOTO 1690 'CHECK ACTUAL MEASURED
CURRENT
1680 ICK = ICK + 1 : GOTO 1780
1690 IF Y1 = 1 THEN GOSUB 4370 'IF CHARGE CURRENT TOO HIGH SECURE # 1
1700 IF Y2 = 1 THEN GOSUB 4500 'IF CHARGE CURRENT TOO HIGH SECURE # 2
1710 'IF TI = 1 THEN 1770
1720 IF STCHG1 > 0 THEN 1740 'CHG #1 AT 2 AMP?
1730 GOTO 1750
1740 IF CHG1.1# < .2 THEN FS="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 1****:STCHG1=0:GOSUB 4370
1750 IF STCHG2 > 0 THEN 1770
1760 GOTO 1780

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1770 IF CHG1.2M# < .2 THEN FS="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 2****:STCHG2=0:GOSUB 4500
1780 NEXT 'loop back and wait for next clock for next cell
1790 GOSUB 6210 ' CHG1LAT AND CHG2LAT
1800 GOSUB 6000 ' GO COMPUTE CELL AVERAGE
1810 GOSUB 6960 ' GO SUM TOTAL AMP HOURS
1820 IF TOGG = 1 THEN GOSUB 4620 ' DISPLAY 80 CELLS TO SCREEN
1830 GOSUB 4270 : FOR DLY = 1 TO 5000 : NEXT : GOSUB 4270 'TWO BEEPS
1840 IF T1 > 9 THEN GOSUB 3800 : T1 = 0
1850 KEY(7) ON 'enable F7 key
1860 HC1# = 0 : HC2# = 0
1870 LC1# = 3 : LC2# = 3
1880 KEY(7)STOP 'DISABLE F7 UNTIL NEXT KEY(7) ON STATEMENT
1890 GOTO 910 'go reset monitor ckts and start next 80
1900 WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1910 RETURN
1920 ' ***** Cell voltage too high *****
1930 IF LOOP > 40 THEN FS = "CELL OVER VOLTAGE OCCURED " : GOSUB 4500 : RETURN
'OPEN LAST 40 RELAYS AND SECURE CHARGER # 2 AND LOOP BACK
1940 FS = "CELL OVER VOLTAGE OCCURED " : GOSUB 4370 'OPEN FIRST 40 RELAYS A
ND SECURE CHARGER # 1
1950 RETURN 'LOOP BACK TO CONTINUE TO CHECK CELLS ON OTHER CHARGER
1960 ' ***** STOP CHARGE, RESET OUTPUTS *****
1970 GOSUB 2110 'set all analog and digital outputs to zero
1980 PRINT:PRINT:PRINT:PRINT:PRINT
1990 PRINT " ***** BATTERY CHARGE SECURED ***** "
2000 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
2010 GOSUB 2320 'GO PRINT LAST 80 TO "A:LAST80"
2020 PRINT " **** RELAYS HAVE BEEN LATCHED OPEN *****
2030 GOSUB 3430 'GO SOUND THE AUDIO ALARM
2040 PRINT : PRINT FS : PRINT
2050 END
2060 ' ***** SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED " *****
2070 HIGHBYTE = INT(CHG.I / 256)
2080 LOWBYTE = CHG.I - HIGHBYTE * 256
2090 GOSUB 3320 'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
2100 RETURN
2110 ' ***** RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO *****
2120 HIGHBYTE = 0 : LOWBYTE = 0
2130 FOR CHAN = 0 TO 1
2140 GOSUB 3320 'GOSUB D/A OUTPUT CHANNELS 0 & 1
2150 NEXT
2160 DPORT = 0 : DWORD = 20 'BIT TO RESET ALL RELAYS
2170 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
2180 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
2190 DWORD = 0
2200 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
2210 DPORT = 1 : DWORD = 0
2220 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
2230 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
2240 RETURN
2250 '***** Output clock pulse on Port zero Bit zero *****
2260 DPORT = 0 : DWORD = 1
2270 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
2280 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
2290 DWORD = 0
2300 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
2310 RETURN
2320 '***** Go Print last 80 to A:LAST80 *****
2330 'OPEN "O",#2,"A:LAST80" 'OPEN FILE TO STORE LAST 80 CELL VALUES
2340 OPEN "lpt1:" FOR OUTPUT AS #2
2350 ON ERROR GOTO 7110 'PRINTER on line BUTTON NOT ENABLE
2360 PRINT#2, " CHARGE IN PROGRESS LASTEST 80 CELL VALUES "
2370 PRINT#2,TIMES;" DATE " ;DATE$ 'ANNOTATE TIME
2380 PRINT#2,
2390 FOR P = 1 TO 80 'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
2400 IF CEVS(P) = 1 THEN 2430 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
2410 LCS = B$
2420 GOTO 2440
2430 LCS = A$
2440 IF PRNTFLG = 0 THEN 2520
2450 PRINT#2, " "; 'PRINT CELL VALUE AND RELAY LATCH
2460 PRINT#2, USING " ##";P;
2470 PRINT#2, " "; 'PRINT CELL VALUE AND RELAY LATCH
2480 PRINT#2, USING " #.###";CV#(P); 'CONDITON
2490 PRINT#2, D$ ; LCS
2500 PRNTFLG = 0
2510 GOTO 2580
2520 PRINT#2, " "; 'PRINT CELL VALUE AND RELAY LATCH
2530 PRINT#2, USING " ##";P;
2540 PRINT#2, " "; 'PRINT CELL VALUE AND RELAY LATCH
2550 PRINT#2, USING " #.###";CV#(P); 'CONDITON
2560 PRINT#2, D$ ; LCS;
2570 PRNTFLG = 1
2580 NEXT
2590 PRINT#2,
2600 PRINT#2, "CELL AVERAGE = ";
2610 PRINT#2, USING " #.###";CELLAVG#;
2620 PRINT#2, " TOTAL BATTERY VOLTAGE = ";
2630 PRINT#2, USING " ###.###";TOTCELL.VAL#

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2640 PRINT#2,
2650 PRINT#2, " ** TOTAL AH CHG #1 = ";
2660 PRINT#2, USING "###.##";TOTAL1.AH#;
2670 PRINT#2, " ** TOTAL AH CHG #2 = ";
2680 PRINT#2, USING "###.##";TOTAL2.AH#
2690 PRINT#2,
2700 PRINT#2, "HIGH CELLS ARE CELL NO. "; HC1N; " ";
2710 PRINT#2, USING "###.##"; HC1#;
2720 PRINT#2, " AND CELL NO. "; HC2N; " ";
2730 PRINT#2, USING "###.##"; HC2#
2740 PRINT#2, "LOW CELLS ARE CELL NO. "; LC1N; " ";
2750 PRINT#2, USING "###.##"; LC1#;
2760 PRINT#2, " AND CELL NO. "; LC2N; " ";
2770 PRINT#2, USING "###.##"; LC2#
2780 PRINT#2,
2790 PRINT#2, " ACTUAL CURRENT ";
2800 PRINT#2, " COMMANDED CURRENT"
2810 PRINT#2, " CHARGER #1 (CELLS 1 THRU 40) IS ";
2820 PRINT#2, USING "###.##"; CHG1.1M#;
2830 PRINT#2, " AMPS ";CHG.11#;" AMPS"
2840 PRINT#2, " CHARGER #2 (CELLS 41 THRU 80) IS ";
2850 PRINT#2, USING "###.##"; CHG1.2M#;
2860 PRINT#2, " AMPS ";CHG.12#;" AMPS"
2870 PRINT#2,
2880 CLOSE#2 : RETURN
2890 '***** A/D CONVERSION *****
2900 GOSUB 1900
2910 OUT COMMAND.REGISTER, &HC 'start A/D conversion to measure SET CHAN
2920 GOSUB 1900
2930 OUT DATA.REGISTER, SETGAIN 'set gain
2940 GOSUB 1900
2950 OUT DATA.REGISTER, SETCHAN 'A/D conversion on SET CHAN
2960 WAIT STATUS.REGISTER, READ.WAIT
2970 LOW1# = INP(DATA.REGISTER) 'get data low byte
2980 WAIT STATUS.REGISTER, READ.WAIT
2990 HIGH1# = INP(DATA.REGISTER) 'get data high byte
3000 RETURN
3010 ' ***** CHECK ACTUAL CHARGE CURRENT *****
3020 SETGAIN = 3 : SETCHAN = 3 ' GAIN RANGE +/- 1.25
3030 GOSUB 2890 ' A/D CONVERSION
3040 CHG1.1M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
3050 IF (CHG1.1M# - CHG.11#) > 1.75 THEN GOTO 3070 'IS DIFF > .5 AMPS
3060 GOTO 3090
3070 Y1 = 1
3080 FS = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
3090 SETGAIN = 3 : SETCHAN = 2 ' GAIN RANGE +/- 1.25
3100 GOSUB 2890 ' A/D CONVERSION
3110 CHG1.2M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
3120 IF (CHG1.2M# - CHG.12#) > 1.75 THEN GOTO 3140 'IS DIFF > .5 AMPS
3130 GOTO 3160
3140 Y2 = 1
3150 FS = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
3160 RETURN
3170 ' ***** DIGITAL I/O PREPARE *****
3180 GOSUB 1900
3190 WAIT STATUS.REGISTER, COMMAND.WAIT
3200 OUT COMMAND.REGISTER, 5 'PREPARE I/O PORT FOR OUTPUT
3210 GOSUB 1900
3220 OUT DATA.REGISTER, DPORT 'SET PORT ZERO FOR OUTPUT
3230 RETURN
3240 ' ***** DIGITAL I/O OUTPUT *****
3250 WAIT STATUS.REGISTER, COMMAND.WAIT
3260 OUT COMMAND.REGISTER, 7 'COMMAND IMMEDIATE DIGITAL OUTPUT
3270 GOSUB 1900
3280 OUT DATA.REGISTER, DPORT 'SELECTED OUTPUT PORT
3290 GOSUB 1900
3300 OUT DATA.REGISTER, DWORD 'BITS TO SET HGH
3310 RETURN
3320 ' ***** D/A OUTPUT ON SELECTED CHANNEL (CHAN) *****
3330 GOSUB 1900
3340 WAIT STATUS.REGISTER, COMMAND.WAIT
3350 OUT COMMAND.REGISTER, CDAOUT 'IMMEDIATE D/A OUT
3360 GOSUB 1900
3370 OUT DATA.REGISTER, CHAN 'D/A CHANNEL SELECTED
3380 GOSUB 1900
3390 OUT DATA.REGISTER, LOWBYTE
3400 GOSUB 1900
3410 OUT DATA.REGISTER, HIGHBYTE
3420 RETURN
3430 ' ***** SOUND CONTINUOUS AUDIO ALARM *****
3440 DPORT = 1 : DWORD = 2
3450 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
3460 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
3470 RETURN
3480 ' ***** STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS ****
3490 OPEN "LPT1:" FOR OUTPUT AS #3 'PRINT FOLLOWING ON THE PRINTER
3500 CHGRTCM = 1 ' SET CHARGE RATE CHANGE FLAG FOR PRINTER ERROR ROUTH
3510 ON ERROR GOTO 7110 'PRINTER on line BUTTON NOT ENABLE
3520 PRINT#3, : PRINT#3, : PRINT#3,
3530 PRINT#3, DATES;" ";TIMES;" **** CHARGE CURRENT RATE CHANGE OCCUR

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ED *****
3540 PRINT#3, "CELL NUMBER "; LOOP ; "WAS ";
3550 PRINT#3, USING "###.###"; CELL.VALUE#;
3560 PRINT#3, " V"
3570 PRINT#3, CEVS : PRINT#3,
3580 PRINT#3, CLCS : PRINT#3,
3590 PRINT#3, "***** ACTUAL CURRENT ***** "
3600 PRINT#3, "CHARGER # 1 ";
3610 PRINT#3, USING "###.###"; CHG1.1M#;
3620 PRINT#3, " AMPS"; " CHARGER # 2 ";
3630 PRINT#3, USING "###.###"; CHG1.2M#;
3640 PRINT#3, " AMPS"
3650 PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS ";CHG.11#; " AMPS CHARGER
# 2 IS ";CHG.12#;" AMPS"
3660 PRINT#3, : PRINT#3,
3670 PRINT#3, FS : CLOSE#3 : GOSUB 4270 : GOSUB 4270 'SOUND TWO TONES
3680 RETURN
3690 '***** TRIGGER CEV ENABLE ON PORT ONE BIT ZERO *****
3700 DPORT = 1 : DWORD = 1
3710 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
3720 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
3730 DWORD = 0
3740 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
3750 RETURN
3760 '***** RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *****
3770 FS = " *** BOTH CHARGERS SET TO 2 AMP RATE ****
3780 GOSUB 3480 'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3790 RETURN
3800 ' ***** PRINT TO C:\BAS\TEMP1 *****
3810 IF TMP = 1 THEN TEMP1$ = "NOPRNT" : GOTO 3830
3820 TEMP1$ = "TEMP1"
3830 OPEN "a", #1, TEMP1$
3840 PRINT#1, : PRINT#1,
3850 PRINT#1, " ***** ";DATES; " ***** "; TIMES; " *****"
3860 PRINT#1,
3870 FOR NW = 1 TO 80
3880 IF CEVS(NW) = 1 THEN 3910 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
3890 LCS = BS
3900 GOTO 3920
3910 LCS = AS
3920 IF PRNFLG = 0 THEN 3980
3930 PRINT#1, " ";NW; 'PRINT CELL VALUE AND RELAY LATCH
3940 PRINT#1, USING "###.###";CV#(NW); 'CONDITON
3950 PRINT#1, DS ; LCS
3960 PRNFLG = 0
3970 GOTO 4020
3980 PRINT#1, NW; 'PRINT CELL VALUE AND RELAY LATCH
3990 PRINT#1, USING "###.###";CV#(NW); 'CONDITON
4000 PRINT#1, DS ; LCS;
4010 PRNFLG = 1
4020 NEXT
4030 PRINT#1, " CHARGER # 1 ";
4040 PRINT#1, USING "###.###"; CHG1.1M#;
4050 PRINT#1, " AMPS"; " CHARGER # 2 ";
4060 PRINT#1, USING "###.###"; CHG1.2M#;
4070 PRINT#1, " AMPS"
4080 PRINT#1, " CHARGE AT ";FS;
4090 PRINT#1, " CELL AVERAGE = ";
4100 PRINT#1, USING "###.###";CELLAVG#
4110 PRINT#1, "HIGH CELLS ARE CELL NO. "; HC1N; " ";
4120 PRINT#1, USING "###.###"; HC1#;
4130 PRINT#1, " AND CELL NO. ";HC2N; " ";
4140 PRINT#1, USING "###.###"; HC2#
4150 PRINT#1, "LOW CELLS ARE CELL NO. "; LC1N; " ";
4160 PRINT#1, USING "###.###"; LC1#;
4170 PRINT#1, " AND CELL NO. ";LC2N; " ";
4180 PRINT#1, USING "###.###"; LC2#
4190 PRINT#1, " ** TOTAL AH CHG #1 = ";
4200 PRINT#1, USING "###.###";TOTAL1.AH#;
4210 PRINT#1, " ** TOTAL AH CHG #2 = ";
4220 PRINT#1, USING "###.###";TOTAL2.AH#
4230 PRINT#1, " ***** ";DATES; " ***** "; TIMES; " *****"
4240 CLOSE#1
4250 GOSUB 4270 : GOSUB 4270 : GOSUB 4270 : GOSUB 4270 '4 BEEPS
4260 RETURN
4270 ' ***** SEND OUT A BEEP *****
4280 DPORT = 1 : DWORD = 0
4290 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
4300 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
4310 DPORT = 1 : DWORD = 2
4320 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
4330 FOR Q = 1 TO 1000 : NEXT 'DELAY FOR TWO SECONDS
4340 DWORD = 0 'TURN OFF ALARM
4350 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
4360 RETURN
4370 ' *** SECURE FIRST 40 RELAYS STOP CHARGER # 1 ***
4380 CHG.1 = 0 : CHAN = 0 : GOSUB 2060 ' STOP CHARGER # 1
4390 DPORT = 0 : DWORD = 4 'RESET RELAYS 1 - 40 J2/48
4400 GOSUB 3170 : GOSUB 3240 'DIG I/O PREPARE : DIG I/O OUTPUT
4410 DWORD = 0 : GOSUB 3240

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4420 CEVS = " ***** CHARGER # 1 SECURED *****
4430 CLCS = " ***** RELAYS 1 THRU 40 RESET OPEN *****
4440 CHG.I1# = 0 : STCHG1 = 0
4450 GOSUB 3480 'SOUND TWO BEEPS AND PRINT MSGS
4460 GOSUB 3430 'GO SOUND CONTINUOUS ALARM
4470 FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
4480 RETURN
4490 '
4500 ' *** SECURE LAST 40 RELAYS STOP CHARGER # 2 ***
4510 CHG.I = 0 : CHAN = 1 : GOSUB 2060 ' STOP CHARGER # 2
4520 DPORT = 0 : DWORD = 16 'RESET RELAYS 41 - 80 J2/47
4530 GOSUB 3170 : GOSUB 3240 'DIG I/O PREPARE : DIG I/O OUTPUT
4540 DWORD = 0 : GOSUB 3240
4550 CEVS = " ***** CHARGER # 2 SECURED *****
4560 CLCS = " ***** RELAYS 41 THRU 80 RESET OPEN *****
4570 CHG.I2# = 0 : STCHG2 = 0
4580 GOSUB 3480 'SOUND TWO BEEPS AND PRINT MSGS
4590 GOSUB 3430 'GO SOUND CONTINUOUS ALARM
4600 FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
4610 RETURN
4620 ' ***** print to screen all cell values
4630 ' and print the current from both chargers *****
4640 PRINT
4650 PRINT " 1 2 3 4 5 6 7 8 9
10"
4660 PRINT " 1";
4670 PRINT USING " ###.###"; CV#(1); CV#(2); CV#(3); CV#(4); CV#(5); CV#(6); CV#(7); CV#(8); CV#(9); CV#(10)
4680 PRINT
4690 PRINT " 11";
4700 PRINT USING " ###.###"; CV#(11); CV#(12); CV#(13); CV#(14); CV#(15); CV#(16); CV#(17); CV#(18); CV#(19); CV#(20)
4710 PRINT
4720 PRINT " 21";
4730 PRINT USING " ###.###"; CV#(21); CV#(22); CV#(23); CV#(24); CV#(25); CV#(26); CV#(27); CV#(28); CV#(29); CV#(30)
4740 PRINT
4750 PRINT " 31";
4760 PRINT USING " ###.###"; CV#(31); CV#(32); CV#(33); CV#(34); CV#(35); CV#(36); CV#(37); CV#(38); CV#(39); CV#(40)
4770 PRINT
4780 PRINT " 41";
4790 PRINT USING " ###.###"; CV#(41); CV#(42); CV#(43); CV#(44); CV#(45); CV#(46); CV#(47); CV#(48); CV#(49); CV#(50)
4800 PRINT
4810 PRINT " 51";
4820 PRINT USING " ###.###"; CV#(51); CV#(52); CV#(53); CV#(54); CV#(55); CV#(56); CV#(57); CV#(58); CV#(59); CV#(60)
4830 PRINT
4840 PRINT " 61";
4850 PRINT USING " ###.###"; CV#(61); CV#(62); CV#(63); CV#(64); CV#(65); CV#(66); CV#(67); CV#(68); CV#(69); CV#(70)
4860 PRINT
4870 PRINT " 71";
4880 PRINT USING " ###.###"; CV#(71); CV#(72); CV#(73); CV#(74); CV#(75); CV#(76); CV#(77); CV#(78); CV#(79); CV#(80)
4890 PRINT
4900 PRINT "CELL AVERAGE = ";
4910 PRINT USING "###.###"; CELAVG#;
4920 PRINT " ** TOTAL AH CHG #1 = ";
4930 PRINT USING "###.###"; TOTAL1.AH#;
4940 PRINT " ** TOTAL AH CHG #2 = ";
4950 PRINT USING "###.###"; TOTAL2.AH#;
4960 PRINT "HIGH CELLS ARE CELL NO. "; HC1N; " ";
4970 PRINT USING "###.###"; HC1#;
4980 PRINT " AND CELL NO. "; HC2N; " ";
4990 PRINT USING "###.###"; HC2#;
5000 PRINT "LOW CELLS ARE CELL NO. "; LC1N; " ";
5010 PRINT USING "###.###"; LC1#;
5020 PRINT " AND CELL NO. "; LC2N; " ";
5030 PRINT USING "###.###"; LC2#;
5040 PRINT "TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40 "; CHG1LAT; " FOR CELLS 41 THRU 80 "; CHG2LAT;
5050 PRINT " COMMANDED CURRENT CHARGER # 1 IS "; CHG.I1#; " AMPS CHARGER # 2 IS "; CHG.I2#; " AMPS"
5060 PRINT " ACTUAL MEASURED CURRENT CHARGER # 1 ";
5070 PRINT USING "###.###"; CHG1.1M#;
5080 PRINT " AMPS"; " CHARGER # 2 ";
5090 PRINT USING "###.###"; CHG1.2M#;
5100 PRINT " AMPS"
5110 RETURN
5120 ' ***** TOGGLE DISPLAY ON/OFF *****
5130 IF TOGG = 1 THEN 5150
5140 IF TOGG = 0 THEN 5160
5150 TOGG = 0 : GOTO 5170
5160 TOGG = 1
5170 RETURN
5180 '
5190 ' ***** PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY *****
5200 '

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5210 PRINT "CELL NUMBER "; LOOP; LCS; " CELL VALUE IS";
5220 PRINT USING "###.###"; CELL.VALUE#
5230 PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL;
5240 PRINT " "; FS
5250 PRINT "CHARGER # 1 ";
5260 PRINT USING "###.###"; CHG1.1M#;
5270 PRINT " AMPS"; " CHARGER # 2 ";
5280 PRINT USING "###.###"; CHG1.2M#;
5290 PRINT " AMPS"
5300 PRINT "COMMANDED CURRENT CHARGER # 1 IS ";CHG.11#; "AMPS CHARGER # 2
IS " ;CHG.12#;"AMPS"
5310 PRINT : PRINT
5320 FOR PRDL = 1 TO 2000 : NEXT
5330 RETURN
5340
5350 / ***** ADJUST CHG.1 FOR OUTPUT CURRENT CHANGES *****
5360 / *** CHARGER # 1 CURRENT CHANGE ONLY *****
5370 CHAN = 0 : GOSUB 2060 : RETURN
5380 / *** CHARGER # 2 CURRENT CHANGE ONLY *****
5390 CHAN = 1 : GOSUB 2060 : RETURN
5400 / *** CHANGE CURRENT ON BOTH CHARGERS *****
5410 GOSUB 5360 : GOSUB 5380 : RETURN
5420
5430 / ***** DISPLAY MEASURED CURRENT *****
5440 FOR CC = 1 TO 5
5450 GOSUB 3010 / GET CHG1.1M# AND CHG1.2M#
5460 PRINT "CHARGER # 1 ";
5470 PRINT USING "###.###"; CHG1.1M#;
5480 PRINT " AMPS"; " CHARGER # 2 ";
5490 PRINT USING "###.###"; CHG1.2M#;
5500 PRINT " AMPS"
5510 PRINT : PRINT
5520 FOR CCO = 1 TO 1000 : NEXT
5530 NEXT
5540 PRINT "IS CURRENT MEASURED OK? (y,n)"
5550 CCQ$ = INPUT$(1)
5560 IF CCQ$ = "y" THEN RETURN
5570 IF CCQ$ = "n" THEN 5590
5580 GOTO 5540
5590 PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
5600 CCQ$ = INPUT$(1)
5610 IF CCQ$ = "y" THEN 5720
5620 IF CCQ$ = "n" THEN 5640
5630 GOTO 5590
5640 PRINT "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.11# : PRINT
5650 PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
5660 INPUT CHG.11#
5670 IF STCHG OR STCHG1 > 0 THEN 5690 '2 AMP RATE RELAY ENABLE SET
5680 GOTO 5700
5690 IF CHG.11# > 2.5 THEN GOSUB 6440 : GOTO 5640
5700 CHG.1 = CHG.11# * 255
5710 GOSUB 5360 : GOTO 5440
5720 PRINT "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.12# : PRINT
5730 PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
5740 INPUT CHG.12#
5750 IF STCHG OR STCHG2 > 0 THEN 5770 '2 AMP RATE RELAY ENABLE SET
5760 GOTO 5780
5770 IF CHG.12# > 2.2 THEN GOSUB 6440 : GOTO 5720
5780 CHG.1 = CHG.12# * 255
5790 GOSUB 5380 : GOTO 5440
5800 / ***** PRINT RELAY LATCH CONDITIONS *****
5810 PRINT
5820 PRINT " RELAY LATCH CONDITIONS ( 0 = OPEN 1 = CLOSED )" : PRINT
5830 PRINT " 1 2 3 4 5 6 7 8
9 10"
5840 PRINT : PRINT
5850 PRINT " ";CEVS(1);" ";CEVS(2);" ";CEVS(3);" ";CEVS(4);"
";CEVS(5);" ";CEVS(6);" ";CEVS(7);" ";CEVS(8);" ";CEVS(9);"
";CEVS(10)
5860 PRINT " ";CEVS(11);" ";CEVS(12);" ";CEVS(13);" ";CEVS(14)
";CEVS(15);" ";CEVS(16);" ";CEVS(17);" ";CEVS(18);" ";CEV
S(19);" ";CEVS(20)
5870 PRINT " ";CEVS(21);" ";CEVS(22);" ";CEVS(23);" ";CEVS(24)
";CEVS(25);" ";CEVS(26);" ";CEVS(27);" ";CEVS(28);" ";CEV
S(29);" ";CEVS(30)
5880 PRINT " ";CEVS(31);" ";CEVS(32);" ";CEVS(33);" ";CEVS(34)
";CEVS(35);" ";CEVS(36);" ";CEVS(37);" ";CEVS(38);" ";CEV
S(39);" ";CEVS(40)
5890 PRINT " ";CEVS(41);" ";CEVS(42);" ";CEVS(43);" ";CEVS(44)
";CEVS(45);" ";CEVS(46);" ";CEVS(47);" ";CEVS(48);" ";CEV
S(49);" ";CEVS(50)
5900 PRINT " ";CEVS(51);" ";CEVS(52);" ";CEVS(53);" ";CEVS(54)
";CEVS(55);" ";CEVS(56);" ";CEVS(57);" ";CEVS(58);" ";CEV
S(59);" ";CEVS(60)
5910 PRINT " ";CEVS(61);" ";CEVS(62);" ";CEVS(63);" ";CEVS(64)
";CEVS(65);" ";CEVS(66);" ";CEVS(67);" ";CEVS(68);" ";CEV
S(69);" ";CEVS(70)
5920 PRINT " ";CEVS(71);" ";CEVS(72);" ";CEVS(73);" ";CEVS(74)
";CEVS(75);" ";CEVS(76);" ";CEVS(77);" ";CEVS(78);" ";CEV
S(79);" ";CEVS(80)

```

```

5930 RETURN
5940 ' ***** SECURE AUDIO ALARM *****
5950 DPORT = 1 : DWORD = 0
5960 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
5970 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
5980 RETURN
5990 '
6000 ' ***** COMPUTE CELL AVERAGE *****
6010 CELLAVG# = 0 : TOTCELL.VAL# = 0
6020 FOR CA = 1 TO 80
6030 TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
6040 NEXT
6050 CELLAVG# = TOTCELL.VAL# / 72
6060 RETURN
6070 ' ***** print test cell and return to stop *****
6080 PRINT "cell number "; LOOP;" is ";
6090 PRINT USING "#.###"; CELL.VALUE#;
6100 PRINT " volts"
6110 RETURN
6120 '***** OUTPUT PULSE TO RESET COUNTERS AND MONITOR CIRCUIT *****
6130 DPORT = 0
6140 GOSUB 3170 'GOSUB DIGITAL I/O PREPARATION
6150 DWORD = 8
6160 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
6170 DWORD = 0
6180 GOSUB 3240 'GOSUB DIGITAL I/O OUTPUT
6190 GOSUB 2250 'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
6200 RETURN
6210 ' *** record cevs totals for both chargers and tot.cell *****
6220 TOT.CELL = 0 : CHG1LAT = 0 : CHG2LAT = 0
6230 FOR CLTS = 1 TO 40
6240 IF CEVS(CLTS) = 1 THEN 6260 ' SUM LATCHED CELLS FOR CHG #1
6250 GOTO 6270
6260 CHG1LAT = CHG1LAT + 1
6270 NEXT
6280 FOR CLTS = 41 TO 80
6290 IF CEVS(CLTS) = 1 THEN 6310 ' SUM LATCHED CELLS FOR CHG #2
6300 GOTO 6320
6310 CHG2LAT = CHG2LAT + 1
6320 NEXT
6330 IF CHG1LAT => 38 THEN CHG1LAT = 0 : FS = " ***** 95% OF FIRST 40 L
6340 ***** : GOSUB 4370 ' SECURE CHG #1 AND OPEN RELAYS 1-40
6350 IF CHG2LAT => 38 THEN CHG2LAT = 0 : FS = " ***** 95% OF LAST 40 LA
6360 ***** : GOSUB 4500 ' SECURE CHG #2 AND OPEN RELAYS 41-80
6370 RETURN
6380 ' ***** SET HC1# TO CV#(LOOP) *****
6390 HC1# = CV#(LOOP)
6400 HC1N = LOOP
6410 RETURN
6420 ' ***** SET HC2# TO CV#(LOOP) *****
6430 HC2# = CV#(LOOP)
6440 HC2N = LOOP
6450 RETURN
6460 '***** ALERT OPERATOR TO SET CURRENT BELOW 2.2 AMPS *****
6470 PRINT
6480 PRINT "RELAY ENABLE IS SET FOR THE CELLS AFFECTED BY THIS CHARGER !!"
6490 PRINT : PRINT " ***** 2 AMPS OR LESS *****"
6500 PRINT : PRINT " PRESS ANY KEY TO CONTINUE "
6510 CONTINUE$ = INPUT$(1)
6520 RETURN
6530 '***** SECURE CHARGER NO. 1, NO CHARGER CURRENT *****
6540 FS = ***** NO CHARGER CURRENT WITH RELAY ENABLE SET ON CHARGER NO. 1 **
6550 ** : GOSUB 4370 : STCHG = 0 : STCHG1 = 0
6560 RETURN
6570 '***** SECURE CHARGER NO. 2, NO CHARGER CURRENT *****
6580 FS = ***** NO CHARGER CURRENT WITH RELAY ENABLE SET ON CHARGER NO. 2 **
6590 ** : GOSUB 4500 : STCHG = 0 : STCHG2 = 0
6600 RETURN
6610 '*** CHECK IF LOOP ON 1-40 OR 41-80 THEN SECURE APPLICABLE CHARGER ***
6620 IF LOOP < 41 THEN GOSUB 4370 : RETURN
6630 GOSUB 4500
6640 RETURN
6650 ' ***** SET HIGH CELL (LC1#) TO CV#(LOOP) *****
6660 LC1# = CV#(LOOP)
6670 LC1N = LOOP
6680 RETURN
6690 ' ***** SET LOW CELL (LC2#) TO CV#(LOOP) *****
6700 LC2# = CV#(LOOP)
6710 LC2N = LOOP
6720 RETURN
6730 ' ***** SET CELL ENABLE VOLTAGE RELAY LATCH (CEVS) *****
6740 PRINT "RELAY CELL NUMBER ?"
6750 INPUT CN
6760 CEVS(CN) = 1
6770 PRINT "INPUT RELAY CELL NUMBER? (y,n)"
6780 RCVS$ = INPUT$(1)
6790 IF RCVS$ = "y" THEN GOTO 6690
6800 IF RCVS$ = "n" THEN RETURN
6810 GOTO 6730
6820 '***** STORE AMP-HOURS OUT TO HARD DISC *****

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6790 PRINT "INPUT AMP-HOURS FROM BATTERY DISCHARGE"
6800 INPUT AMPHOUR
6810 OPEN "A", #1, "TEMP1"
6820 PRINT#1, : PRINT#1, : PRINT#1,
6830 PRINT#1, TIMES; " DATE "; DATE$ 'ANNOTATE TIME AND DATE
6840 PRINT#1, : PRINT#1,
6850 PRINT#1, : PRINT#1,
6860 PRINT#1, " ***** AMP HOURS OUT SINCE LAST CHARGE IS ";
6870 PRINT#1, AMPHOUR; " ***** 'PRINT AMPHOUR FROM DISCHARGE
6880 PRINT#1, : PRINT#1,
6890 CLOSE#1
6900 RETURN
6910 ' ***** SET PREDECTIME# FOR AMPHOUR SUMS AT START OF CURRENT COMMAND ***
6920 GOSUB 7050 ' RETURNS VASLUE FOR TIME (DECTIME#); IN HOURS
6930 DECTIMESTART# = DECTIME#
6940 PREVDECTIME# = DECTIME#-1/3600
6950 RETURN
6960 ' ***** SUM THE TOTAL AMP-HOURS TOTAL1.AH# AND TOTAL2.AH# *****
6970 GOSUB 7050
6980 DELTATIME# = DECTIME# - PREVDECTIME#
6990 DELTA1.AH# = CHG1.1M# * DELTATIME#
7000 DELTA2.AH# = CHG1.2M# * DELTATIME#
7010 TOTAL1.AH# = TOTAL1.AH# + DELTA1.AH#
7020 TOTAL2.AH# = TOTAL2.AH# + DELTA2.AH#
7030 PREVDECTIME# = DECTIME#
7040 RETURN
7050 ' ***** GET DECIMAL TIME (DECTIME#); IN HOURS *****
7060 HR = VAL(MID$(TIMES,1,2))
7070 MIN# = VAL(MID$(TIMES,4,2))/60
7080 SEC# = VAL(MID$(TIMES,7,2))/3600
7090 DECTIME# = HR + MIN# + SEC#
7100 RETURN
7110 '***** printer error subroutine *****
7120 GOSUB 3430 'CONTINUOUS TONE
7130 TMP = 1
7140 PRINT
7150 PRINT
7160 PRINT
7170 PRINT "PRINTER NOT ON LINE"
7180 PRINT
7190 PRINT FS
7200 GOSUB 2110 'RESETS RELAYS AND CHARGERS
7210 PRINT
7220 PRINT " ***** CHARGERS # 1 & # 2 SECURED *****"
7230 PRINT
7240 PRINT " ***** RELAYS 1 THRU 80 RESET OPENED *****"
7250 PRINT
7260 IF CHGRICHN = 1 THEN 7290
7270 GOSUB 7370 ' PRINT PUT PRINTER ON LINE
7280 GOSUB 2360 : STOP 'GO PRINT LAST 80 THEN STOP
7290 PRINT "CHARGE SECURED DO YOU WISH TO PRINT MSG ?"
7300 PRNRSS = INPUT$(1)
7310 IF PRNRSS = "y" THEN GOTO 7340
7320 IF PRNRSS = "n" THEN GOTO 7350
7330 GOTO 7290
7340 GOSUB 7370 : GOSUB 3520 : STOP
7350 PRINT " DATA TO HARD DISC FILE -- NOPRINT "
7360 GOSUB 3800 : STOP 'DATA TO HARD DISC
7370 ' ***** PRINT MSG TO PUT PRINTER ON LINE ***** "
7380 PRINT "PUT PRINTER ON LINE AND PRESS ANY KEY"
7390 CONTT$ = INPUT$(1)
7400 GOSUB 4270 'TURN OFF CONTINUOUS BEEP
7410 PRINT "PROGRAM SECURED "
7420 RETURN

```

APPENDIX E—BATTERY DISCHARGE PROGRAMS “DISCHGL.BAS” AND “DISCHGH.BAS”

```

10  '***** DISCHGL.BAS as of 04/08/92   TIME 1500 *****
20  ' CELL VALUE < 1.30 UNLATCHES RELAY
30  DEFINT A-Z 'assign all letters as integers
40  OPEN "A:", #1, "TEMP1"
50  PRINT#1, DATES
60  CLOSE#1
70  WIDTH "lpt1:",78
80  BASE.ADDRESS = &H2EC 'DT 2801 memory assignments
90  COMMAND.REGISTER = BASE.ADDRESS + 1
100 STATUS.REGISTER = BASE.ADDRESS + 1
110 DATA.REGISTER = BASE.ADDRESS
120 COMMAND.WAIT = &H4
130 WRITE.WAIT = &H2
140 READ.WAIT = &H5
150 CCLEAR = &H1
160 CADIN = &HC 'HMc = ext trigger, &Hc = continuous
170 CSTOP = &HF
180 CDAOUT = &H8
190 STCHG = 0
200 LOWCELL# = 1.6
210 DIM CV#(80) 'DIMENSION CELL VALUE (CV#)
220 DIM CEVS(80) 'DIMENSION CELL VALUE (CV#)
230 DIM CL#(80) 'DIMENSION CELL LATCH (CL#)
240 DIM COV(80) 'DIMENSION CELL OVER VOLTAGE (COV)
250 DIM Z(80) 'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
260 AS = "LATCHED"
270 BS = "NOT LATCHED"
280 CS = "CELL NUMBER "
290 DS = "V RELAY IS "
300 OUT COMMAND.REGISTER, CSTOP
310 TEMP = INP(DATA.REGISTER)
320 GOSUB 1460
330 WAIT STATUS.REGISTER, COMMAND.WAIT
340 OUT COMMAND.REGISTER, CCLEAR
350 '***** PROMPT FOR RESET OUTPUTS AT START UP *****
360 PRINT "RESET ALL OUTPUTS? (y,n)"
370 RSTIS = INPUT$(1)
380 IF RSTIS = "y" THEN 410
390 IF RSTIS = "n" THEN 430
400 GOTO 360
410 GOSUB 1720 'set all analog and digital outputs to zero
420 TOT.CELL = 0
430 ON KEY(1) GOSUB 5740 'F1 key to PRINT 80 cv#.cl# to PRINTER
440 ON KEY(2) GOSUB 3710 'F2 key display last 80 cells to 8 rows
450 ON KEY(3) GOSUB 4120 'F3 key to toggle displayed data on/off
460 ON KEY(4) GOSUB 4750 'F4 key to display last 80 latch conditions
470 ON KEY(6) GOSUB 4440 'F6 key allows for current changes
480 ON KEY(10) GOSUB 4890 'F10 key STOPS CONTINUOUS ALARM
490 PRINT "DO YOU WANT TO SET ALL RELAYS?"
500 SETRS = INPUT$(1)
510 IF SETRS = "y" THEN GOSUB 5360 : GOTO 870
520 IF SETRS = "n" THEN 870
530 GOTO 820
540 LOWCELL# = 1.7 : HIGHCELL# = 1!
550 '***** OUTPUT PULSE TO RESET COUNTERS AND MONITOR CIRCUIT *****
560 DPORT = 0
570 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
580 DWORD = 8
590 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
600 DWORD = 0
610 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
620 GOSUB 1860 'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
630 '***** Loop 80 times waiting each time for the sample Pulse ***
640 IF TI > 9 THEN GOSUB 3070 : TI = 0
650 TI = TI + 1
660 FOR LOOP = 1 TO 80 'start 80 samples
670 GOSUB 1860 'clock to incr monitor circuits
680 Y1 = 0 : Y2 = 0
690 SETGAIN = 2: SETCHAN = 7 'RANGE IS +/- 2.5 **** CELL.VALUE# **
700 CVAVG# = 0
710 FOR CVA = 1 TO 3 'AVERAGE CV# 5 TIMES
720 GOSUB 1930 'A/D CONVERSION FOR CV# VALUE
730 CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
740 CELL.VALUE# = ABS (CELL.VALUE#)
750 CVAVG# = CVAVG# + CELL.VALUE#
760 NEXT
770 CELL.VALUE# = CVAVG# / 3 'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
780 'IF LOOP = 85 THEN GOSUB 5340 : STOP
790 GOSUB 1860 'output clock to trigger A/D on hardware
800 IF LOOP = 19 THEN 1380
810 IF LOOP = 20 THEN 1380
820 IF LOOP = 39 THEN 1380
830 IF LOOP = 40 THEN 1380
840 IF LOOP = 59 THEN 1380
850 IF LOOP = 60 THEN 1380
860 IF LOOP = 79 THEN 1380
870 IF LOOP = 80 THEN 1380
880 KEY(1) ON 'enable F1 key
890 KEY(2) ON 'enable F2 key

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1240 KEY(3) ON 'enable F3 key
1250 KEY(4) ON 'enable F4 key
1260 KEY(6) ON 'enable F6 key
1270 KEY(10) ON 'enable F10 key
1280 IF CELL.VALUE# < 1.3 THEN GOTO 1300 'reset relay to open discharge path
1290 GOTO 1320
1300 GOSUB 2960 ' GO TRIGGER RELAY ENABLE
1310 CEVS(LOOP) = 0 : GOSUB 5640 ' SET CEVS INDICATOR AND SUM TOT.CELLS
1320 CV#(LOOP) = CELL.VALUE#
1330 IF CV#(LOOP) < LOWCELL# THEN GOSUB 5320 ' GO SET LCNUM TO loop
1340 IF CV#(LOOP) > HIGHCELL# THEN GOSUB 5700 ' GO SET HCNUM TO loop
1350 IF TOT.CELL => 80 THEN FS = " 80 RELAYS HAD LATCHED"
1360 IF CELL.VALUE# < 1.185 THEN 5220 'GO PRINT CELL LESS THAN 1.185 VOLTS
1370 IF TOGG = 0 THEN GOSUB 4170 'GO PRINT EACH CELL VALUE AND INFO
1380 NEXT 'loop back and wait for next clock for next cell
1390 GOSUB 3320 : GOSUB 5620 : GOSUB 3320 'BEEP,DELAY,BEEP
1400 GOSUB 4950 ' GO COMPUTE CELL AVERAGE
1410 IF TOGG < 1 THEN 1430
1420 GOSUB 3710 ' go print to screen 80 cells and low cell
1430 LOWCELL# = 1.7 : HIGHCELL# = 1!
1440 ' next
1450 GOTO 880 'go reset monitor ckts and start next 80
1460 WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1470 RETURN
1480 ' ***** Cell voltage too high *****
1490 IF COV(LOOP) > 0 THEN 1540 'HAS COV OCCURED BEFORE
1500 COV(LOOP) = 1 'THE CELL HAS COV SO INDICATE FOR NEXT CHECK
1510 PRINT USING "#.###";
1520 RETURN 'RETURN TO LOOP FOR NEXT CELL.VALUE
1530 PRINT " V"
1540 IF LOOP > 40 THEN FS = "CELL OVER VOLTAGE OCCURED TWICE" : GOSUB 3600 : R
1550 'OPENED LAST 40 RELAYS AND SECURED CHARGER # 2 AND LOOP BACK
1560 FS = "CELL OVER VOLTAGE OCCURED TWICE CELL" : GOSUB 3480 'OPENED FIRST
1570 ' ***** STOP CHARGE, RESET OUTPUTS *****
1580 GOSUB 1720 'set all analog and digital outputs to zero
1590 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
1600 PRINT " ***** BATTERY CHARGE SECURED ***** "
1610 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
1620 GOSUB 1900 'GO PRINT LAST 80 TO "A:LAST80"
1630 PRINT " ***** RELAYS HAVE BEEN LATCHED OPEN *****"
1640 GOSUB 2480 'GO SC'ND THE AUDIO ALARM
1650 PRINT : PRINT FS : PRINT
1660 END
1670 ' ***** SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED " *****
1680 HIGHBYTE = INT(CHG.I / 256)
1690 LOWBYTE = CHG.I - HIGHBYTE * 256
1700 GOSUB 2370 'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
1710 RETURN
1720 ' ***** RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO *****
1730 HIGHBYTE = 0 : LOWBYTE = 0
1740 FOR CHAN = 0 TO 1
1750 GOSUB 2370 'GOSUB D/A OUTPUT CHANNELS 0 & 1
1760 NEXT
1770 DPORT = 0 : DWORD = 20 'BIT TO RESET ALL RELAYS
1780 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
1790 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
1800 DWORD = 0
1810 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
1820 DPORT = 1 : DWORD = 0
1830 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
1840 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
1850 RETURN
1860 '***** Output clock pulse on Port zero Bit zero *****
1870 DPORT = 0 : DWORD = 1
1880 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
1890 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
1900 DWORD = 0
1910 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
1920 RETURN
1930 '***** A/D CONVERSION *****
1940 GOSUB 1460
1950 OUT COMMAND.REGISTER, &HC 'start A/D conversion to measure SET CHAN
1960 GOSUB 1460
1970 OUT DATA.REGISTER, SETGAIN 'set gain
1980 GOSUB 1460
1990 OUT DATA.REGISTER, SETCHAN 'A/D conversion on SET CHAN
2000 WAIT STATUS.REGISTER, READ.WAIT
2010 LOW1# = INP(DATA.REGISTER) 'get data low byte
2020 WAIT STATUS.REGISTER, READ.WAIT
2030 HIGH1# = INP(DATA.REGISTER) 'get data high byte
2040 RETURN
2050 ' ***** CHECK ACTUAL CHARGE CURRENT *****
2060 SETGAIN = 3 : SETCHAN = 3 ' GAIN RANGE +/- 1.25
2070 GOSUB 1930 ' A/D CONVERSION
2080 CHG1.1M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
2090 IF (CHG1.1M# - CHG.I1#) > 1.75 THEN GOTO 2180 'IS DIFF > .5 AMPS
2100 GOTO 2130
2110 Y1 = 1

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2120 FS = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
2130 SETGAIN = 3 : SETCHAN = 2 ' GAIN RANGE +/- 1.25
2140 GOSUB 1930 ' A/D CONVERSION
2150 CHG1.2M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
2160 IF (CHG1.2M# - CHG.12M#) > 1.75 THEN GOTO 2180 'IS DIFF > .5 AMPS
2170 GOTO 2200
2180 Y2 = 1
2190 FS = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
2200 RETURN
2210 ' ***** DIGITAL I/O PREPARE *****
2220 GOSUB 1460
2230 WAIT STATUS.REGISTER, COMMAND.WAIT
2240 OUT COMMAND.REGISTER, 5 'PREPARE I/O PORT FOR OUTPUT
2250 GOSUB 1460
2260 OUT DATA.REGISTER, DPORT 'SET PORT ZERO FOR OUTPUT
2270 RETURN
2280 ' ***** DIGITAL I/O OUTPUT *****
2290 GOSUB 1460
2300 WAIT STATUS.REGISTER, COMMAND.WAIT
2310 OUT COMMAND.REGISTER, 7 'COMMAND IMMEDIATE DIGITAL OUTPUT
2320 GOSUB 1460
2330 OUT DATA.REGISTER, DPORT 'SELECTED OUTPUT PORT
2340 GOSUB 1460
2350 OUT DATA.REGISTER, DWORD 'BITS TO SET HIGH
2360 RETURN
2370 ' ***** D/A OUTPUT ON SELECTED CHANNEL (CHAN) *****
2380 GOSUB 1460
2390 WAIT STATUS.REGISTER, COMMAND.WAIT
2400 OUT COMMAND.REGISTER, CDAOUT 'IMMEDIATE D/A OUT
2410 GOSUB 1460
2420 OUT DATA.REGISTER, CHAN 'D/A CHANNEL SELECTED
2430 GOSUB 1460
2440 OUT DATA.REGISTER, LOWBYTE
2450 GOSUB 1460
2460 OUT DATA.REGISTER, HIGHBYTE
2470 RETURN
2480 ' ***** SOUND CONTINUOUS AUDIO ALARM *****
2490 DPORT = 1 : DWORD = 2
2500 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
2510 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
2520 RETURN
2530 ' ***** SOUND THREE ALARMS AND APPEND CELL NUMBER TO
2540 ' FILE * CV#DIFF * *****
2550 GOSUB 3320 : GOSUB 3320 : GOSUB 3320
2560 ' OPEN "A", #4, "A:CV#DIFF" 'OPEN FILE TO STORE LAST 80 CELL VALUES
2570 OPEN "LPT1:" FOR OUTPUT AS #4 'PRINT FOLLOWING ON THE PRINTER
2580 PRINT#4, : PRINT#4, : PRINT#4,
2590 PRINT#4, " " ; TIMES ; " " DATE " ; DATES
2600 PRINT#4, CEVS : PRINT#4,
2610 PRINT#4, "CELL " ; LOOP ; "VALUE IS " ;
2620 PRINT#4, USING "###.###" ; CELL.VALUE# ;
2630 PRINT#4, " VOLTS"
2640 PRINT#4, CLCS
2650 PRINT#4,
2660 PRINT#4, ***** ACTUAL CURRENT IS *****
2670 PRINT#4, "CHARGER # 1 " ;
2680 PRINT#4, USING "###.###" ; CHG1.1M# ;
2690 PRINT#4, "AMPS" ; " " CHARGER # 2 " ;
2700 PRINT#4, USING "###.###" ; CHG1.2M# ;
2710 PRINT#4, " AMPS"
2720 PRINT#4, "COMMANDED CURRENT CHARGER # 1 IS " ; CHG.11# ; "AMPS" CHARGER
# 2 IS " ; CHG.12# ; "AMPS"
2730 PRINT#4, : PRINT#4,
2740 CLOSE#4
2750 RETURN
2760 ' ***** STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS *****
2770 ' OPEN "A", #3, "A:CEVCHGR"
2780 OPEN "LPT1:" FOR OUTPUT AS #3 'PRINT FOLLOWING ON THE PRINTER
2790 PRINT#3, : PRINT#3, : PRINT#3,
2800 PRINT#3, TIMES ; " ***** CHARGE CURRENT RATE CHANGE OCCURRED *****
2810 PRINT#3, "CELL NUMBER " ; LOOP ; "WAS " ;
2820 PRINT#3, USING "###.###" ; CELL.VALUE# ;
2830 PRINT#3, " V"
2840 PRINT#3, CEVS : PRINT#3,
2850 PRINT#3, CLCS : PRINT#3,
2860 PRINT#3, ***** ACTUAL CURRENT *****
2870 PRINT#3, "CHARGER # 1 " ;
2880 PRINT#3, USING "###.###" ; CHG1.1M# ;
2890 PRINT#3, " AMPS" ; " " CHARGER # 2 " ;
2900 PRINT#3, USING "###.###" ; CHG1.2M# ;
2910 PRINT#3, " AMPS"
2920 PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS " ; CHG.11# ; " AMPS" CHARGER
# 2 IS " ; CHG.12# ; " AMPS"
2930 PRINT#3, : PRINT#3,
2940 PRINT#3, FS : CLOSE#3 : GOSUB 3320 : GOSUB 3320 'SOUND TWO TONES
2950 RETURN
2960 '***** TRIGGER CEV ENABLE ON PORT ONE BIT ZERO *****
2970 DPORT = 1 : DWORD = 1
2980 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
2990 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT

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3000 DWORD = 0
3010 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
3020 RETURN
3030 '***** RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *****
3040 FS = " *** BOTH CHARGERS SET TO 2 AMP RATE ****"
3050 GOSUB 2760 'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3060 RETURN
3070 ' ***** PRINT TO C:\BAS\TEMP1 *****
3080 OPEN "a", #1, "DISCHGL.TEM"
3090 PRINT#1, : PRINT#1, : PRINT#1,
3100 PRINT#1, " "; TIMES ;" DATE "; DATES
3110 FOR NW = 1 TO 80
3120 IF CEVS(NW) = 1 THEN 3150 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
3130 LCS = BS
3140 GOTO 3160
3150 LCS = AS
3160 PRINT#1, NW; 'PRINT CELL VALUE AND RELAY LATCH
3170 PRINT#1, USING "###";CV#(NW); 'CONDITON
3180 PRINT#1, DS ; LCS
3190 NEXT
3191 PRINT#1, " "; TIMES ;" DATE "; DATES
3200 GOSUB 3320 : GOSUB 3320 : GOSUB 3320 : GOSUB 3320 '4 BEEPS
3210 PRINT#1, "HIGH CELL NO. IS "; HCNUM; " ";
3220 PRINT#1, USING "###"; HIGHCELL#
3230 PRINT#1, "LOW CELL NO. IS "; LCNUM; " ";
3240 PRINT#1, USING "###"; LOWCELL#
3250 PRINT#1,
3260 PRINT#1, " TOTAL CELLS ABOVE LOW VOLTAGE CUTOFF AND STILL LATCHED IS ";
3261 PRINT#1, USING "##"; TOT.CELL
3270 PRINT "CELL AVERAGE = ";
3280 PRINT USING "###";CELLAVG#
3290 PRINT#1, DATES
3300 CLOSE#1
3310 RETURN
3320 ' ***** SEND OUT A BEEP *****
3330 DPORT = 1 : DWORD = 2
3340 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
3350 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
3360 FOR Q = 1 TO 1000 : NEXT 'DELAY FOR TWO SECONDS
3370 DWORD = 0 'TURN OFF ALARM
3380 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
3390 RETURN
3400 ' ***** INCREMENT COUNT OF RESPECTIVE GROUP OF 40 *****
3410 IF LOOP < 41 THEN 3440
3420 CHG2LAT = CHG2LAT + 1
3430 GOTO 3450
3440 CHG1LAT = CHG1LAT + 1
3450 IF CHG1LAT => 40 THEN CHG1LAT = 0 : FS = " ***** FIRST 40 HAD LA
TCHED
***** : GOSUB 3480
3460 IF CHG2LAT => 40 THEN CHG2LAT = 0 : FS = " ***** LAST 40 HAD LAT
CHED
***** : GOSUB 3600
3470 RETURN
3480 ' *** SECURE FIRST 40 RELAYS STOP CHARGER # 1 ***
3490 CHG.I = 0 : CHAN = 0 : GOSUB 1670 ' STOP CHARGER # 1
3500 DPORT = 0 : DWORD = 4 'RESET RELAYS 1 - 40 J2/48
3510 GOSUB 2210 : GOSUB 2280 'DIG I/O PREPARE : DIG I/O OUTPUT
3520 DWORD = 0 : GOSUB 2280
3530 CEVS = " ***** CHARGER # 1 SECURED *****
3540 CLCS = " ***** RELAYS 1 THRU 40 RESET OPEN *****
3550 GOSUB 2760 'SOUND TWO BEEPS AND PRINT MSGS
3560 GOSUB 2480 'GO SOUND CONTINUOUS ALARM
3570 FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
3580 RETURN
3590 '
3600 ' *** SECURE LAST 40 RELAYS STOP CHARGER # 2 ***
3610 CHG.I = 0 : CHAN = 1 : GOSUB 1670 ' STOP CHARGER # 2
3620 DPORT = 0 : DWORD = 16 'RESET RELAYS 41 - 80 J2/47
3630 GOSUB 2210 : GOSUB 2280 'DIG I/O PREPARE : DIG I/O OUTPUT
3640 DWORD = 0 : GOSUB 2280
3650 CEVS = " ***** CHARGER # 2 SECURED *****
3660 CLCS = " ***** RELAYS 41 THRU 80 RESET OPEN *****
3670 GOSUB 2760 'SOUND TWO BEEPS AND PRINT MSGS
3680 GOSUB 2480 'GO SOUND CONTINUOUS ALARM
3690 FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
3700 RETURN
3710 ' ***** print to screen all cell values
3720 ' and print the current from both chargers *****
3730 PRINT
3740 PRINT " 1 2 3 4 5 6 7 8 9
10"
3750 PRINT " 1";
3760 PRINT USING " ###.###";CV#(1);CV#(2);CV#(3);CV#(4);CV#(5);CV#(6);CV#(7);CV#(8);CV#(9);CV#(10)
3770 PRINT
3780 PRINT " 11";
3790 PRINT USING " ###.###";CV#(11);CV#(12);CV#(13);CV#(14);CV#(15);CV#(16);CV#(17);CV#(18);CV#(19);CV#(20)
3800 PRINT
3810 PRINT " 21";
3820 PRINT USING " ###.###";CV#(21);CV#(22);CV#(23);CV#(24);CV#(25);CV#(26);CV#

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(27);CV#(28);CV#(29);CV#(30)
3830 PRINT
3840 PRINT "31";
3850 PRINT USING " ###.###";CV#(31);CV#(32);CV#(33);CV#(34);CV#(35);CV#(36);CV#
(37);CV#(38);CV#(39);CV#(40)
3860 PRINT
3870 PRINT "41";
3880 PRINT USING " ###.###";CV#(41);CV#(42);CV#(43);CV#(44);CV#(45);CV#(46);CV#
(47);CV#(48);CV#(49);CV#(50)
3890 PRINT
3900 PRINT "51";
3910 PRINT USING " ###.###";CV#(51);CV#(52);CV#(53);CV#(54);CV#(55);CV#(56);CV#
(57);CV#(58);CV#(59);CV#(60)
3920 PRINT
3930 PRINT "61";
3940 PRINT USING " ###.###";CV#(61);CV#(62);CV#(63);CV#(64);CV#(65);CV#(66);CV#
(67);CV#(68);CV#(69);CV#(70)
3950 PRINT
3960 PRINT "71";
3970 PRINT USING " ###.###";CV#(71);CV#(72);CV#(73);CV#(74);CV#(75);CV#(76);CV#
(77);CV#(78);CV#(79);CV#(80)
3980 PRINT
3990 PRINT "CELL AVERAGE = ";
4000 PRINT USING "###.###";CELLAVG#
4010 PRINT "LOW CELL = ";
4020 PRINT USING "###.###";LOWCELL#;
4030 PRINT " THE LOW CELL NUMBER IS # "; LCNUM;" ";
4040 PRINT "HIGH CELL = ";
4050 PRINT USING "###.###";HIGHCELL#;
4060 PRINT " THE HIGH CELL NUMBER IS # "; HCNUM
4070 PRINT
4071 CELLSDIS = 72 - TOT.CELL
4080 PRINT " TOTAL CELLS DISCHARGED IS ";
4090 PRINT USING "###"; CELLSDIS
4100 RETURN
4110 ' ***** TOGGLE DISPLAY ON/OFF *****
4120 IF TOGG = 1 THEN 4140
4130 IF TOGG = 0 THEN 4150
4140 TOGG = 0 : GOTO 4160
4150 TOGG = 1
4160 RETURN
4170 ' ***** PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY *****
4180 PRINT "CELL NUMBER "; LOOP ; LCS; " CELL VALUE IS";
4190 PRINT USING "###.###"; CELL.VALUE#
4200 PRINT
4210 PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL
4220 PRINT
4230 PRINT " THE HIGH CELL NUMBER IS # ";
4240 PRINT USING "###";HCNUM;
4250 PRINT " ";
4260 PRINT USING "###.###"; HIGHCELL#;
4270 PRINT " V"
4280 PRINT " THE LOW CELL NUMBER IS # ";
4290 PRINT USING "###";LCNUM;
4300 PRINT " ";
4310 PRINT USING "###.###"; LOWCELL#;
4320 PRINT " V"
4330 PRINT : PRINT : PRINT
4340 FOR PRDL = 1 TO 5000 : NEXT
4350 RETURN
4360 ' ***** ADJUST CHG.I FOR OUTPUT CURRENT CHANGES *****
4370 ' *** CHARGER # 1 CURRENT CHANGE ONLY *****
4380 CHAN = 0 : GOSUB 1670 : RETURN
4390 ' *** CHARGER # 2 CURRENT CHANGE ONLY *****
4400 CHAN = 1 : GOSUB 1670 : RETURN
4410 ' *** CHANGE CURRENT ON BOTH CHARGERS *****
4420 GOSUB 4370 : GOSUB 4390 : RETURN
4430 '
4440 ' ***** DISPLAY MEASURED CURRENT *****
4450 FOR CC = 1 TO 5
4460 GOSUB 2050 ' GET CHG1.1M# AND CHG1.2M#
4470 PRINT "CHARGER # 1 ";
4480 PRINT USING "###.###"; CHG1.1M#;
4490 PRINT " AMPS"; " CHARGER # 2 ";
4500 PRINT USING "###.###"; CHG1.2M#;
4510 PRINT " AMPS"
4520 PRINT : PRINT
4530 FOR CCO = 1 TO 1000 : NEXT
4540 NEXT
4550 PRINT "IS CURRENT MEASURED OK? (y,n)"
4560 CCQS = INPUT$(1)
4570 IF CCQS = "y" THEN RETURN
4580 IF CCQS = "n" THEN 4600
4590 GOTO 4550
4600 PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
4610 CCQS = INPUT$(1)
4620 IF CCQS = "y" THEN 4700
4630 IF CCQS = "n" THEN 4650
4640 GOTO 4600
4650 PRINT "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.11# : PRINT

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4660 PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
4670 INPUT CHG.1#
4680 CHG.1 = CHG.1# * 255
4690 GOSUB 4370 : GOTO 4450
4700 PRINT "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.12# : PRINT
4710 PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
4720 INPUT CHG.12#
4730 CHG.1 = CHG.12# * 255
4740 GOSUB 4390 : GOTO 4450
4750 / ***** PRINT RELAY LATCH CONDITIONS *****
4760 PRINT
4770 PRINT "RELAY LATCH CONDITIONS ( 0 = OPEN 1 = CLOSED )" : PRINT
4780 PRINT " 1 2 3 4 5 6 7 8
9 10"
4790 PRINT : PRINT
4800 PRINT " ";CEVS(1);" ";CEVS(2);" ";CEVS(3);" ";CEVS(4);"
";CEVS(5);" ";CEVS(6);" ";CEVS(7);" ";CEVS(8);" ";CEVS(9);"
";CEVS(10)
4810 PRINT " ";CEVS(11);" ";CEVS(12);" ";CEVS(13);" ";CEVS(14)
";CEVS(15);" ";CEVS(16);" ";CEVS(17);" ";CEVS(18);" ";CEV
S(19);" ";CEVS(20)
4820 PRINT " ";CEVS(21);" ";CEVS(22);" ";CEVS(23);" ";CEVS(24)
";CEVS(25);" ";CEVS(26);" ";CEVS(27);" ";CEVS(28);" ";CEV
S(29);" ";CEVS(30)
4830 PRINT " ";CEVS(31);" ";CEVS(32);" ";CEVS(33);" ";CEVS(34)
";CEVS(35);" ";CEVS(36);" ";CEVS(37);" ";CEVS(38);" ";CEV
S(39);" ";CEVS(40)
4840 PRINT " ";CEVS(41);" ";CEVS(42);" ";CEVS(43);" ";CEVS(44)
";CEVS(45);" ";CEVS(46);" ";CEVS(47);" ";CEVS(48);" ";CEV
S(49);" ";CEVS(50)
4850 PRINT " ";CEVS(51);" ";CEVS(52);" ";CEVS(53);" ";CEVS(54)
";CEVS(55);" ";CEVS(56);" ";CEVS(57);" ";CEVS(58);" ";CEV
S(59);" ";CEVS(60)
4860 PRINT " ";CEVS(61);" ";CEVS(62);" ";CEVS(63);" ";CEVS(64)
";CEVS(65);" ";CEVS(66);" ";CEVS(67);" ";CEVS(68);" ";CEV
S(69);" ";CEVS(70)
4870 PRINT " ";CEVS(71);" ";CEVS(72);" ";CEVS(73);" ";CEVS(74)
";CEVS(75);" ";CEVS(76);" ";CEVS(77);" ";CEVS(78);" ";CEV
S(79);" ";CEVS(80)
4880 RETURN
4890 / ***** SECURE AUDIO ALARM *****
4900 DPORT = 1 : DWORD = 0
4910 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
4920 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
4930 RETURN
4940 /
4950 / ***** COMPUTE CELL AVERAGE *****
4960 CELLAVG# = 0
4970 TOTCELL.VAL# = 0
4980 FOR CA = 1 TO 80
4990 IF CA = 19 THEN 5090
5000 IF CA = 20 THEN 5090
5010 IF CA = 39 THEN 5090
5020 IF CA = 40 THEN 5090
5030 IF CA = 59 THEN 5090
5040 IF CA = 60 THEN 5090
5050 IF CA = 79 THEN 5090
5060 IF CA = 80 THEN 5090
5070 CELLAVG# = CELLAVG# + CV#(CA)
5080 TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
5090 NEXT
5100 CELLAVG# = CELLAVG# / 72
5110 RETURN
5120 /
5130 / ***** CELL.VALUE# GREATER THAN 2.3 VOLTS RESET CEV# TO 0 *****
5140 CEV# = 0 : CELL.VALUE# = CELL.VALUE#/2
5150 RETURN
5160 /
5170 / ***** print test cell and return to stop *****
5180 PRINT "cell number "; LOOP;" is ";
5190 PRINT USING "#.###"; CELL.VALUE#;
5200 PRINT " volts"
5210 RETURN
5220 / ***** STOP DISCHARGE CELL BELOW 1.185V *****
5221 CEVS = " ***** CELL BELOW 1.20 VOLTS *****"
5222 CLCS = " ALL RELAYS LATCHED OPEN : DISCHARGE SECURED "
5230 GOSUB 2530 ' SOUND THRE BEEPS AND PRINT PROBLEM CELL
5240 GOSUB 3320 ' BEEP
5250 GOSUB 1720 ' RESET ALL OUTPUTS TO OPEN RELAYS AND STOP DISCHG
5260 GOSUB 1900
5270 PRINT " DO YOU WISH TO CONTINUE PROGRAM? (y,n)"
5280 QUEST# = INPUT$(1)
5290 IF QUEST# = "y" THEN GOTO 320
5300 IF QUEST# = "n" THEN STOP
5310 GOTO 5270
5320 / **** SET LCNUM TO LOOP ****
5330 LOWCELL# = CV#(LOOP)
5340 LCNUM = LOOP
5350 RETURN
5360 / ***** SET ALL RELAYS FOR RESISTOR DISCHARGE *****

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5370 DPORT = 0
5380 GOSUB 2210 'GOSUB DIGITAL I/O PREPARATION
5390 DWORD = 8
5400 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
5410 DWORD = 0
5420 GOSUB 2280 'GOSUB DIGITAL I/O OUTPUT
5430 GOSUB 1860 'output clock
5440 GOSUB 1860 ' OUTPUT CLOCK
5450 FOR DLOOP = 1 TO 80
5460 GOSUB 1860 ' OUTPUT CLOCK
5470 PRINT "LATCH CELL RELAY NUMBER ";DLOOP; "?"
5480 RLATS = INPUT$(1)
5490 IF RLATS = "y" THEN 5520
5500 IF RLATS = "n" THEN 5530
5510 GOTO 5470
5520 GOSUB 2960 : CEVS(DLOOP) = 1 ' TRIGGER CEV ENABLE ON HARDWARE
5530 GOSUB 1860 ' OUTPUT CLOCK
5540 GOSUB 5620 ' GO SUB TO DELAY
5550 NEXT
5560 GOSUB 5640 ' GO COMPUTE THE TOTAL CELLS LATCHED
5570 PRINT "ARE THE CONNECTORS CHANGED? "
5580 CCNG$ = INPUT$(1)
5590 IF CCNG$ = "y" THEN 5610
5600 GOTO 5570
5610 RETURN
5620 FOR DLY = 1 TO 1000 : NEXT
5630 RETURN
5640 '**** SUM THE TOTAL CELLS (TOT.CELL) FROM CEVS(1-80) *****
5650 TOT.CELL = 0
5660 FOR TOTCELL = 1 TO 80
5670 TOT.CELL = TOT.CELL + CEVS(TOTCELL)
5680 NEXT
5690 RETURN
5700 ' **** SET HCNUM TO LOOP **** *
5710 HIGHCELL# = CV$(LOOP)
5720 HCNUM = LOOP
5730 RETURN
5740 '***** Go Print last 80 to PRINTER *****
5750 OPEN "lpt1:" FOR OUTPUT AS #2
5760 PRINT#2,
5770 PRINT#2, " **** DISCHARGE IN PROGRESS AT LOW CURRENT RATE ***
5780 PRINT#2,
5790 PRINT#2, " ";TIMES;" DATE " ;DATES$ 'ANNOTATE TIME
5800 PRINT#2,
5810 FOR P = 1 TO 80 'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
5820 IF CEVS(P) = 1 THEN 5870 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
5830 LC$ = B$ ' B$ = NOT LATCHED
5840 GOTO 5880
5850 LC$ = A$ ' AS = LATCHED D$ = V RELAY IS
5860 IF PRNTFLG = 0 THEN 5940
5870 PRINT#2, " ";
5880 PRINT#2, USING " ##";P;
5890 PRINT#2, USING " #.###";CV$(P);
5900 PRINT#2, USING " \";D$ ;
5910 PRINT#2, USING " \";LC$
5920 PRNTFLG = 0
5930 GOTO 5980
5940 PRINT#2, USING " ##";P;
5950 PRINT#2, USING " #.###";CV$(P); 'CONDITON
5960 PRINT#2, USING " \";D$ ;
5970 PRINT#2, USING " \";LC$;
5980 PRNTFLG = 1
5990 NEXT
6000 PRINT#2, "CELL AVERAGE = ";
6010 PRINT#2, USING " #.###";CELLAVG#;
6020 PRINT#2, " TOTAL BATTERY VOLTAGE = ";
6030 PRINT#2, USING " ###.##";TOTCELL.VAL#
6040 PRINT#2,
6050 PRINT#2, "HIGH CELL NO. IS "; HCNUM; " ";
6060 PRINT#2, USING " #.###"; HIGHCELL#
6070 PRINT#2, "LOW CELL NO. IS "; LCNUM; " ";
6080 PRINT#2, USING " #.###"; LOWCELL#
6090 PRINT#2,
6100 PRINT#2, " TOTAL CELLS ABOVE LOW VOLTAGE CUTOFF AND STILL LATCHED IS ";
6110 PRINT#2, USING " ##"; TOT.CELL
6120 CLOSE#2 : RETURN

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10      /***** DISCHG.BAS   as of 01/03/92   TIME 1230 *****/
20      /
30      DEFINT A-Z      ' ASSIGN ALL LETTERS AS INTEGERS
40      LC1# = 3 : LC2# = 3 ' SET LOWEST CELLS FOR #1 & #2 CHARGERS ABOVE 0
50      WIDTH "lpt1:",78
60      BASE.ADDRESS = &H2EC      'DT 2801 memory assignments
70      COMMAND.REGISTER = BASE.ADDRESS + 1
80      STATUS.REGISTER = BASE.ADDRESS + 1
90      DATA.REGISTER = BASE.ADDRESS
100     COMMAND.WAIT = &H4
110     WRITE.WAIT = &H2
120     READ.WAIT = &H5
130     CCLEAR = &H1
140     CADIN = &HC ' &H8c = ext trigger, &Hc = continuous
150     CSTOP = &HF
160     CDAOUT = &H8
170     STCHG = 0
180     DIM CV$(80)      'DIMENSION CELL VALUE (CV#)
190     DIM CEVS(80)      'DIMENSION CELL VALUE (CV#)
200     DIM CL$(80)      'DIMENSION CELL LATCH (CL#)
210     DIM COV(80)      'DIMENSION CELL OVER VOLTAGE (COV)
220     DIM Z(80)      'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
230     AS = "LATCHED"
240     BS = "NOT LATCHED"
250     CS = "CELL NUMBER "
260     DS = "V RELAY IS "
270     OUT COMMAND.REGISTER, CSTOP
280     TEMP = INP(DATA.REGISTER)
290     GOSUB 1920
300     WAIT STATUS.REGISTER, COMMAND.WAIT
310     OUT COMMAND.REGISTER, CCLEAR
320     / ***** PROMPT TO RESET OUTPUTS AT START UP *****
330     PRINT "RESET ALL OUTPUTS? (y,n)"
340     RSTIS = INPUT$(1)
350     IF RSTIS = "y" THEN 380
360     IF RSTIS = "n" THEN 460
370     GOTO 330
380     GOSUB 2130      'set all analog and digital outputs to zero
390     / *** PROMPT TO INPUT AMP-HOURS OUT DURING DISCHARGE ***
400     PRINT "STORE AMP-HOURS OUT OF BATTERY DURING DISCHARGE? (y,n)"
410     AHOUTS = INPUT$(1)
420     IF AHOUTS = "y" THEN GOSUB 6970 : GOTO 450
430     IF AHOUTS = "n" THEN 450
440     GOTO 390
450     / ***** INPUT RELAY ENABLE COUNT FROM PREVIOUS RUN *****
460     PRINT "INPUT RELAY CELL NUMBER? (y,n)"
470     RSTOS = INPUT$(1)
480     IF RSTOS = "y" THEN GOSUB 6880 : GOTO 550
490     IF RSTOS = "n" THEN 550
500     GOTO 460
510     PRINT "RELAY CELL NUMBER ?"
520     INPUT CN
530     CEVS(CN) = 1
540     GOTO 420
550     / ***** PROMPT FOR DESIRED CHARGE CURRENT *****
560     PRINT "IS CHARGE CURRENT THE SAME FOR BOTH CHARGERS?"
570     RSCHGS = INPUT$(1)
580     GOSUB 7100
590     IF RSCHGS = "y" THEN 740
600     IF RSCHGS = "n" THEN GOSUB 7100 : GOTO 620
610     GOTO 560
620     PRINT "IS EITHER CHARGER AT THE 2 AMP RATE? (y,n)"
630     CHGRTS = INPUT$(1)
640     IF CHGRTS = "y" THEN 670
650     IF CHGRTS = "n" THEN 720
660     GOTO 620
670     PRINT " WHICH CHARGER IS AT THE 2 AMP RATE? ( 1 OR 2 )"
680     INPUT CHGNO
690     IF CHGNO = 1 THEN CEVL = 1 : STCHG1 = 1 : GOSUB 5580 : GOTO 850
700     IF CHGNO = 2 THEN CEVH = 1 : STCHG2 = 1 : GOSUB 5580 : GOTO 850
710     GOTO 670
720     GOSUB 5580
730     GOTO 850
740     PRINT " WHAT IS CHARGE CURRENT IN AMPS? ( TYPE 0, 2 OR 7 )" : PRINT
750     INPUT CHG.I
760     IF CHG.I = 0 THEN 800
770     IF CHG.I = 2 THEN 820
780     IF CHG.I = 7 THEN CHG.I = 100 : GOTO 840
790     GOTO 660
800     CHG.I = 0 : F$ = " 0 AMP RATE " : CHG.I1# = 0 : CHG.I2# = J
810     GOTO 850
820     CHG.I1# = 2 : CHG.I2# = 2 : F$ = " 2 AMP RATE " : STCHG = 2 : CHG.I = 510 : STCHG1 = 1
: STCHG2 = 1 : GOSUB 5550 ' SRT CHGS & AM CLOCK
830     GOTO 850
840     CHG.I1# = 7 : CHG.I2# = 7 : F$ = " 7 AMP RATE " : GOSUB 5550
850     ON KEY(1) GOSUB 2340      'F1 key to PRN 80 cv# & cl# to Printer
860     ON KEY(2) GOSUB 4770      'F2 key display last 80 cells to 8 rows
870     ON KEY(3) GOSUB 5280      'F3 key to toggle displayed data on/off
880     ON KEY(4) GOSUB 5950      'F4 key to display last 80 latch conditions
890     ON KEY(6) GOSUB 5580      'F6 key allows for current changes

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900 ON KEY(7) GOSUB 3990 'F7 key sends data to hard disc temp1
910 ON KEY(10) GOSUB 6090 'F10 key STOPS CONTINUOUS ALARM
920 ***** OUTPUT PULSE TO RESET COUNTERS AND MONITOR CIRCUIT *****
930 GOSUB 6270 ' GO OUTPUT RESET
940
950 ***** Loop 80 times waiting each time for the sample Pusle ***
960 TI = TI + 1
970 FOR LOOP = 1 TO 80 'start 80 samples
980 GOSUB 2270 'clock to incr monitor circuits
990 Y1 = 0 : Y2 = 0
1000 SETGAIN = 2: SETCHAN = 7 'RANGE IS +/- 2.5 **** CELL.VALUE# **
1010 CVAVG# = 0
1020 FOR CVA = 1 TO 3 'AVERAGE CV# 5 TIMES
1030 GOSUB 2860 ' A/D CONVERSION FOR CV# VALUE
1040 CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
1050 CELL.VALUE# = ABS (CELL.VALUE#)
1060 CVAVG# = CVAVG# + CELL.VALUE#
1070 NEXT
1080 CELL.VALUE# = CVAVG# / 3 'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
1090 'IF LOOP = 85 THEN GOSUB 6200 : STOP
1100 GOSUB 2270 'output clock to trigger A/D on hardware
1110 IF LOOP = 19 THEN 1690
1120 IF LOOP = 20 THEN 1690
1130 IF LOOP = 39 THEN 1690
1140 IF LOOP = 40 THEN 1690
1150 IF LOOP = 59 THEN 1690
1160 IF LOOP = 60 THEN 1690
1170 IF LOOP = 79 THEN 1690
1180 IF LOOP = 80 THEN 1690
1190 IF CELL.VALUE# < 1.2 THEN FS = " CELL BELOW 1.20 VOLTS" : GOSUB 6660
1200 ' SETGAIN = 1: SETCHAN = 4 'RANGE IS +/- 5.0 **** READ CEV# ****
1210 ' GOSUB 2470 ' A/D CONVERSION
1220 KEY(1) ON 'enable F1 key
1230 KEY(2) ON 'enable F2 key
1240 KEY(3) ON 'enable F3 key
1250 KEY(4) ON 'enable F4 key
1260 KEY(6) ON 'enable F6 key
1270 'KEY(7) ON 'enable F7 key
1280 KEY(10) ON 'enable F10 key
1290 ' CEV# = (HIGH1#* 256 + LOW1#) * .0024414 - 5 'calculate CEV# value
1300 KEY(6)STOP 'DISABLE F6 UNTIL NEXT KEY ON STATEMENT
1310 CEV# = 0
1320 ' CEV# = ABS(CEV#) 'change bipolar to positive value
1330 IF CELL.VALUE# > 2.05 THEN CEV# = 5
1340 IF CEVS(LOOP) = 1 AND CELL.VALUE# > 2 THEN FS = "CELL LATCHED TO RESISTO
R AND THE VOLTAGE WAS OVER 2.0 VOLTS " : GOSUB 6760
1350 IF CEVS(LOOP) = 1 THEN GOTO 1390
1360 IF CEV# > 3 THEN 1400 ' YES, GO CHECK IF 7 AMP
1370 LCS = BS
1380 GOTO 1590
1390 LCS = AS : GOTO 1580
1400 IF STCHG < 2 THEN 1420 ' YES, GO CHECK 2 AMP RATE ON BOTH CHAARGERS
1410 GOTO 1570
1420 IF LOOP > 40 THEN 1500
1430 IF CEV# = 1 THEN GOSUB 3950 : GOTO 820 'SET CHARGERS TO 2 AMPS PRINT MSG
1440 IF CEVL = 1 THEN 1570
1450 CHG.I1# = 2:CHG.I = 510 : GOSUB 5510 'GO OUTPUT NEW CURRENT on chg #1
1460 CEVL = 1 : STCHG1 = 1
1470 FS = "CHARGER #1 IS AT 2 AMP RATE : CHARGER #2 IS AT 7 AMP RATE"
1480 GOSUB 3680 'PRINT CHARGE RATE CHANGE TO A:CEVCHGRT
1490 GOTO 1590 'RESUME CELL VALUE CHECKS
1500 IF CEVL = 1 THEN GOSUB 3950 : GOTO 820 'SET CHARGERS TO 2 AMPS PRINT MSG
1510 IF CEV# = 1 THEN 1570
1520 CHG.I2# = 2:CHG.I = 510 : GOSUB 5530 'GO OUTPUT NEW CURRENT on chg #2
1530 CEV# = 1 : STCHG2 = 1
1540 FS = "CHARGER #1 IS AT 7 AMP RATE : CHARGER #2 IS AT 2 AMP RATE"
1550 GOSUB 3680 'PRINT CHARGE RATE CHANGE TO A:CEVCHGRT
1560 GOTO 1590
1570 CEVS(LOOP) = 1 ' CELL WAS NOT LATCHED, DO IT
1580 GOSUB 3880 ' GO TRIGGER RELAY ENABLE
1590 CV#(LOOP) = CELL.VALUE#
1600 IF LOOP > 40 THEN 1640
1610 IF CV#(LOOP) > HC1# THEN GOSUB 6510 ' SET HIGH CELL 1st 40 TO CV(LOOP)
1620 IF CV#(LOOP) < LC1# THEN GOSUB 6800 ' SET LOW CELL 1st 40 TO CV(LOOP)
1630 GOTO 1660
1640 IF CV#(LOOP) > HC2# THEN GOSUB 6550 ' SET HIGH CELL 2nd 40 TO CV(LOOP)
1650 IF CV#(LOOP) < LC2# THEN GOSUB 6840 ' SET LOW CELL 2nd 40 TO CV(LOOP)
1660 'IF OV# > 0 THEN 1670 ' If overvoltage flag set don't stop program
1670 'IF CELL.VALUE# > 2.075 THEN GOSUB 1940
1680 IF TOGG = 0 THEN GOSUB 5340 ' GO PRINT CELL INFO TO SCREEN
1690 IF ICK > 7 THEN GOSUB 2980 : ICK = 0 : GOTO 1710 'CHECK ACTUAL MEASURED
CURRENT
1700 ICK = ICK + 1 : GOTO 1800
1710 IF Y1 = 1 THEN GOSUB 4520 'IF CHARGE CURRENT TOO HIGH SECURE # 1
1720 IF Y2 = 1 THEN GOSUB 4650 'IF CHARGE CURRENT TOO HIGH SECURE # 2
1730 'IF TI = 1 THEN 1770
1740 IF STCHG1 > 0 THEN 1760 'CHG #1 AT 2 AMP?
1750 GOTO 1770
1760 IF CHG1.1M# < .2 THEN FS="*** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 1***":STCHG1=0:GOSUB 4520

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1770 IF STCHG2 > 0 THEN 1790
1780 GOTO 1800
1790 IF CHG1.2M# < .2 THEN FS="*** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 2***":STCHG2=0:GOSUB 4650
1800 NEXT 'loop back and wait for next clock for next cell
1810 GOSUB 6360 ' CHG1LAT AND CHG2LAT
1820 GOSUB 6150 ' GO COMPUTE CELL AVERAGE
1830 GOSUB 7150 ' GO SUM TOTAL AMP HOURS
1840 IF TOGG = 1 THEN GOSUB 4770 ' DISPLAY 80 CELLS TO SCREEN
1850 GOSUB 4440 : FOR DLY = 1 TO 5000 : NEXT : GOSUB 4440 'TWO BEEPS
1860 IF T1 > 9 THEN GOSUB 3990 : T1 = 0
1870 KEY(7) ON 'enable F7 key
1880 HC1# = 0 : HC2# = 0
1890 LC1# = 3 : LC2# = 3
1900 KEY(7)STOP 'DISABLE F7 UNTIL NEXT KEY(7) ON STATEMENT
1910 GOTO 920 'go reset monitor ckts and start next 80
1920 WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1930 RETURN
1940 ' ***** Cell voltage too high *****
1950 IF LOOP > 40 THEN FS = "CELL OVER VOLTAGE OCCURED " : GOSUB 4650 : RETURN
'OPEN LAST 40 RELAYS AND SECURE CHARGER # 2 AND LOOP BACK
1960 FS = "CELL OVER VOLTAGE OCCURED " : GOSUB 4520 'OPEN FIRST 40 RELAYS A
ND SECURE CHARGER # 1
1970 RETURN 'LOOP BACK TO CONTINUE TO CHECK CELLS ON OTHER CHARGER
1980 ' ***** STOP CHARGE, RESET OUTPUTS *****
1990 GOSUB 2130 'set all analog and digital outputs to zero
2000 PRINT:PRINT:PRINT:PRINT:PRINT
2010 PRINT " ***** BATTERY CHARGE SECURED ***** "
2020 PRINT:PRINT:PRINT:PRINT:PRINT
2030 GOSUB 2340 'GO PRINT LAST 80 TO "A:LAST80"
2040 PRINT " ***** RELAYS HAVE BEEN LATCHED OPEN *****
2050 GOSUB 3400 'GO SOUND THE AUDIO ALARM
2060 PRINT : PRINT FS : PRINT
2070 END
2080 ' ***** SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED " *****
2090 HIGHBYTE = INT(CHG.I / 256)
2100 LOWBYTE = CHG.I - HIGHBYTE * 256
2110 GOSUB 3290 'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
2120 RETURN
2130 ' ***** RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO *****
2140 HIGHBYTE = 0 : LOWBYTE = 0
2150 FOR CHAN = 0 TO 1
2160 GOSUB 3290 'GOSUB D/A OUTPUT CHANNELs 0 & 1
2170 NEXT
2180 DPORT = 0 : DWORD = 20 'BIT TO RESET ALL RELAYS
2190 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
2200 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
2210 DWORD = 0
2220 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
2230 DPORT = 1 : DWORD = 0
2240 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
2250 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
2260 RETURN
2270 '***** Output clock pulse on Port zero Bit zero *****
2280 DPORT = 0 : DWORD = 1
2290 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
2300 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
2310 DWORD = 0
2320 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
2330 RETURN
2340 '***** Go Print last 80 to A:LAST80 *****
2350 'OPEN "O",#2,"A:LAST80" 'OPEN FILE TO STORE LAST 80 CELL VALUES
2360 OPEN "lpt1:" FOR OUTPUT AS #2
2370 PRINT#2, " ***** A: LAST80 *****
2380 PRINT#2,TIMES;" DATE " ;DATES 'ANNOTATE TIME
2390 PRINT#2,
2400 FOR P = 1 TO 80 'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
2410 IF CEVS(P) = 1 THEN 2440 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
2420 LCS = BS
2430 GOTO 2450
2440 LCS = AS
2450 IF PRNTFLG = 0 THEN 2510
2460 PRINT#2, " ", P, " ", 'PRINT CELL VALUE AND RELAY LATCH
2470 PRINT#2, USING "###";CV#(P); 'CONDITON
2480 PRINT#2, D$ ; LCS
2490 PRNTFLG = 0
2500 GOTO 2550
2510 PRINT#2, " ", P, " ", 'PRINT CELL VALUE AND RELAY LATCH
2520 PRINT#2, USING "###";CV#(P); 'CONDITON
2530 PRINT#2, D$ ; LCS;
2540 PRNTFLG = 1
2550 NEXT
2560 PRINT#2,
2570 PRINT#2, "CELL AVERAGE = ";
2580 PRINT#2, USING "###";CELLAVG#;
2590 PRINT#2, " TOTAL BATTERY VOLTAGE = ";
2600 PRINT#2, USING "###.##";TOTCELL.VAL#
2610 PRINT#2,
2620 PRINT#2, " ** TOTAL AH CHG #1 = ";
2630 PRINT#2, USING "###.##";TOTAL1.AH#;

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2640 PRINT#2, " ** TOTAL AH CHG #2 = ";
2650 PRINT#2, USING "###.##";TOTAL2.AH#
2660 PRINT#2,
2670 PRINT#2, "HIGH CELLS ARE CELL NO. "; HC1N; " ";
2680 PRINT#2, USING "###.##"; HC1#;
2690 PRINT#2, " AND CELL NO. "; HC2N; " ";
2700 PRINT#2, USING "###.##"; HC2#
2710 PRINT#2, "LOW CELLS ARE CELL NO. "; LC1N; " ";
2720 PRINT#2, USING "###.##"; LC1#;
2730 PRINT#2, " AND CELL NO. "; LC2N; " ";
2740 PRINT#2, USING "###.##"; LC2#
2750 PRINT#2,
2760 PRINT#2, " ACTUAL CURRENT ";
2770 PRINT#2, " COMMANDED CURRENT"
2780 PRINT#2, " CHARGER #1 (CELLS 1 THRU 40) IS ";
2790 PRINT#2, USING "###.##"; CHG1.1M#; " ;CHG.11#;" AMPS"
2800 PRINT#2, " AMPS
2810 PRINT#2, " CHARGER #2 (CELLS 41 THRU 80) IS ";
2820 PRINT#2, USING "###.##"; CHG1.2M#; " ;CHG.12#;" AMPS"
2830 PRINT#2, " AMPS
2840 PRINT#2,
2850 CLOSE#2 : RETURN
2860 ***** A/D CONVERSION *****
2870 GOSUB 1920
2880 OUT COMMAND.REGISTER, &HC 'start A/D conversion to measure SET CHAN
2890 GOSUB 1920
2900 OUT DATA.REGISTER, SETGAIN 'set gain
2910 GOSUB 1920
2920 OUT DATA.REGISTER, SETCHAN 'A/D conversion on SET CHAN
2930 WAIT STATUS.REGISTER, READ.WAIT
2940 LOW1# = INP(DATA.REGISTER) 'get data low byte
2950 WAIT STATUS.REGISTER, READ.WAIT
2960 HIGH1# = INP(DATA.REGISTER) 'get data high byte
2970 RETURN
2980 / ***** CHECK ACTUAL CHARGE CURRENT *****
2990 SETGAIN = 3 : SETCHAN = 3 ' GAIN RANGE +/- 1.25
3000 GOSUB 2860 ' A/D CONVERSION
3010 CHG1.1M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
3020 IF (CHG1.1M# - CHG.11#) > 8.75 THEN GOTO 3040 'IS DIFF > .5 AMPS
3030 GOTO 3060
3040 Y1 = 1
3050 FS = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
3060 SETGAIN = 3 : SETCHAN = 2 ' GAIN RANGE +/- 1.25
3070 GOSUB 2860 ' A/D CONVERSION
3080 CHG1.2M# = ((HIGH1#* 256 + LOW1#) * .00061 - 1.25) * 12.5 '
3090 IF (CHG1.2M# - CHG.12#) > 8.75 THEN GOTO 3110 'IS DIFF > .5 AMPS
3100 GOTO 3130
3110 Y2 = 1
3120 FS = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
3130 RETURN
3140 / ***** DIGITAL I/O PREPARE *****
3150 GOSUB 1920
3160 WAIT STATUS.REGISTER, COMMAND.WAIT
3170 OUT COMMAND.REGISTER, 5 'PREPARE I/O PORT FOR OUTPUT
3180 GOSUB 1920
3190 OUT DATA.REGISTER, DPORT 'SET PORT ZERO FOR OUTPUT
3200 RETURN
3210 / ***** DIGITAL I/O OUTPUT *****
3220 WAIT STATUS.REGISTER, COMMAND.WAIT
3230 OUT COMMAND.REGISTER, 7 'COMMAND IMMEDIATE DIGITAL OUTPUT
3240 GOSUB 1920
3250 OUT DATA.REGISTER, DPORT 'SELECTED OUTPUT PORT
3260 GOSUB 1920
3270 OUT DATA.REGISTER, DWORD 'BITS TO SET HIGH
3280 RETURN
3290 / ***** D/A OUTPUT ON SELECTED CHANNEL (CHAN) *****
3300 GOSUB 1920
3310 WAIT STATUS.REGISTER, COMMAND.WAIT
3320 OUT COMMAND.REGISTER, CDAOUT 'IMMEDIATE D/A OUT
3330 GOSUB 1920
3340 OUT DATA.REGISTER, CHAN 'D/A CHANNEL SELECTED
3350 GOSUB 1920
3360 OUT DATA.REGISTER, LOWBYTE
3370 GOSUB 1920
3380 OUT DATA.REGISTER, HIGHBYTE
3390 RETURN
3400 / ***** SOUND CONTINUOUS AUDIO ALARM *****
3410 DPORT = 1 : DWORD = 2
3420 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
3430 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
3440 RETURN
3450 / ***** SOUND THREE ALARMS AND APPEND CELL NUMBER TO
3460 FILE * CV#DIFF * *****
3470 GOSUB 4440 : GOSUB 4440 : GOSUB 4440
3480 OPEN "A",#4,"A:CV#DIFF" 'OPEN FILE TO STORE LAST 80 CELL VALUES
3490 OPEN "LPT1:" FOR OUTPUT AS #4 'PRINT FOLLOWING ON THE PRINTER
3500 PRINT#4, : PRINT#4, : PRINT#4,
3510 PRINT#4, " "; TIMES; " DATE "; DATES
3520 PRINT#4, CEVS : PRINT#4,
3530 PRINT#4, "CELL ";LOOP; "VALUE IS ";

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3540 PRINT#4, USING "###.###"; CELL.VALUE#;
3550 PRINT#4, " VOLTS"
3560 PRINT#4, CLCS
3570 PRINT#4,
3580 PRINT#4, "***** ACTUAL CURRENT IS ***** "
3590 PRINT#4, "CHARGER # 1 ";
3600 PRINT#4, USING "###.###"; CHG1.1M#;
3610 PRINT#4, "AMPS"; " CHARGER # 2 ";
3620 PRINT#4, USING "###.###"; CHG1.2M#;
3630 PRINT#4, " AMPS"
3640 PRINT#4, "COMMANDED CURRENT CHARGER # 1 IS "; CHG.11#; "AMPS CHARGER
# 2 IS "; CHG.12#; "AMPS"
3650 PRINT#4, : PRINT#4,
3660 CLOSE#4
3670 RETURN
3680 ' ***** STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS *****
3690 OPEN "A", #3, "A:CEVCHGRT"
3700 OPEN "LPT1:" FOR OUTPUT AS #3 'PRINT FOLLOWING ON THE PRINTER
3710 PRINT#3, : PRINT#3, : PRINT#3,
3720 PRINT#3, TIMES; " ***** CHARGE CURRENT RATE CHANGE OCCURRED *****
3730 PRINT#3, "CELL NUMBER "; LOOP; "WAS ";
3740 PRINT#3, USING "###.###"; CELL.VALUE#;
3750 PRINT#3, " V"
3760 PRINT#3, CEVS : PRINT#3,
3770 PRINT#3, CLCS : PRINT#3,
3780 PRINT#3, "***** ACTUAL CURRENT ***** "
3790 PRINT#3, "CHARGER # 1 ";
3800 PRINT#3, USING "###.###"; CHG1.1M#;
3810 PRINT#3, " AMPS"; " CHARGER # 2 ";
3820 PRINT#3, USING "###.###"; CHG1.2M#;
3830 PRINT#3, " AMPS"
3840 PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS "; CHG.11#; " AMPS CHARGER
# 2 IS "; CHG.12#; " AMPS"
3850 PRINT#3, : PRINT#3,
3860 PRINT#3, FS : CLOSE#3 : GOSUB 4440 : GOSUB 4440 'SOUND TWO TONES
3870 RETURN
3880 '***** TRIGGER CEV ENABLE ON PORT ONE BIT ZERO *****
3890 DPORT = 1 : DWORD = 1
3900 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
3910 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
3920 DWORD = 0
3930 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
3940 RETURN
3950 '***** RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *****
3960 FS = " *** BOTH CHARGERS SET TO 2 AMP RATE ***"
3970 GOSUB 3680 'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3980 RETURN
3990 ' ***** PRINT TO C:\BAS\TEMP1 *****
4000 OPEN "a", #1, "temp1"
4010 PRINT#1, : PRINT#1,
4020 PRINT#1, " ***** "; DATES; " ***** "; TIMES; " *****
4030 PRINT#1,
4040 FOR NW = 1 TO 80
4050 IF CEVS(NW) = 1 THEN 4080 'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
4060 LCS = BS
4070 GOTO 4090
4080 LCS = AS
4090 IF PRNFLG = 0 THEN 4150
4100 PRINT#1, " "; NW; 'PRINT CELL VALUE AND RELAY LATCH
4110 PRINT#1, USING "###.###"; CV#(NW); 'CONDITON
4120 PRINT#1, DS; LCS
4130 PRNFLG = 0
4140 GOTO 4190
4150 PRINT#1, NW; 'PRINT CELL VALUE AND RELAY LATCH
4160 PRINT#1, USING "###.###"; CV#(NW); 'CONDITON
4170 PRINT#1, DS; LCS;
4180 PRNFLG = 1
4190 NEXT
4200 PRINT#1, " CHARGER # 1 ";
4210 PRINT#1, USING "###.###"; CHG1.1M#;
4220 PRINT#1, " AMPS"; " CHARGER # 2 ";
4230 PRINT#1, USING "###.###"; CHG1.2M#;
4240 PRINT#1, " AMPS"
4250 PRINT#1, " CHARGE AT "; FS;
4260 PRINT#1, " CELL AVERAGE = ";
4270 PRINT#1, USING "###.###"; CELLAVG#
4280 PRINT#1, "HIGH CELLS ARE CELL NO. "; HC1N; " ";
4290 PRINT#1, USING "###.###"; HC1#;
4300 PRINT#1, " AND CELL NO. "; HC2N; " ";
4310 PRINT#1, USING "###.###"; HC2#
4320 PRINT#1, "LOW CELLS ARE CELL NO. "; LC1N; " ";
4330 PRINT#1, USING "###.###"; LC1#;
4340 PRINT#1, " AND CELL NO. "; LC2N; " ";
4350 PRINT#1, USING "###.###"; LC2#
4360 PRINT#1, " ** TOTAL AH CHG #1 = ";
4370 PRINT#1, USING "###.###"; TOTAL1.AH#;
4380 PRINT#1, " ** TOTAL AH CHG #2 = ";
4390 PRINT#1, USING "###.###"; TOTAL2.AH#
4400 PRINT#1, " ***** "; DATES; " ***** "; TIMES; " *****
4410 CLOSE#1

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4420 GOSUB 4440 : GOSUB 4440 : GOSUB 4440 : GOSUB 4440 '4 BEEPS
4430 RETURN
4440 ' ***** SEND OUT A BEEP *****
4450 DPORT = 1 : DWORD = 2
4460 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
4470 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
4480 FOR Q = 1 TO 1000 : NEXT 'DELAY FOR TWO SECONDS
4490 DWORD = 0 'TURN OFF ALARM
4500 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
4510 RETURN
4520 ' *** SECURE FIRST 40 RELAYS STOP CHARGER # 1 ***
4530 CHG.1 = 0 : CHAN = 0 : GOSUB 2080 ' STOP CHARGER # 1
4540 DPORT = 0 : DWORD = 4 'RESET RELAYS 1 - 40 J2/48
4550 GOSUB 3140 : GOSUB 3210 'DIG I/O PREPARE : DIG I/O OUTPUT
4560 DWORD = 0 : GOSUB 3210
4570 CEVS = " ***** CHARGER # 1 SECURED *****"
4580 CLCS = " ***** RELAYS 1 THRU 40 RESET OPEN *****"
4590 CHG.11# = 0 : STCHG1 = 0
4600 GOSUB 3680 'SOUND TWO BEEPS AND PRINT MSGS
4610 GOSUB 3400 'GO SOUND CONTINUOUS ALARM
4620 FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
4630 RETURN
4640 '
4650 ' *** SECURE LAST 40 RELAYS STOP CHARGER # 2 ***
4660 CHG.1 = 0 : CHAN = 1 : GOSUB 2080 ' STOP CHARGER # 2
4670 DPORT = 0 : DWORD = 16 'RESET RELAYS 41 - 80 J2/47
4680 GOSUB 3140 : GOSUB 3210 'DIG I/O PREPARE : DIG I/O OUTPUT
4690 DWORD = 0 : GOSUB 3210
4700 CEVS = " ***** CHARGER # 2 SECURED *****"
4710 CLCS = " ***** RELAYS 41 THRU 80 RESET OPEN *****"
4720 CHG.12# = 0 : STCHG2 = 0
4730 GOSUB 3680 'SOUND TWO BEEPS AND PRINT MSGS
4740 GOSUB 3400 'GO SOUND CONTINUOUS ALARM
4750 FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
4760 RETURN
4770 ' ***** print to screen all cell values
4780 ' and print the current from both chargers *****
4790 PRINT
4800 PRINT " 1 2 3 4 5 6 7 8 9
10"
4810 PRINT "1";
4820 PRINT USING " ##.###";CV#(1);CV#(2);CV#(3);CV#(4);CV#(5);CV#(6);CV#(7);CV
#(8);CV#(9);CV#(10)
4830 PRINT
4840 PRINT "11";
4850 PRINT USING " ##.###";CV#(11);CV#(12);CV#(13);CV#(14);CV#(15);CV#(16);CV#
(17);CV#(18);CV#(19);CV#(20)
4860 PRINT
4870 PRINT "21";
4880 PRINT USING " ##.###";CV#(21);CV#(22);CV#(23);CV#(24);CV#(25);CV#(26);CV#
(27);CV#(28);CV#(29);CV#(30)
4890 PRINT
4900 PRINT "31";
4910 PRINT USING " ##.###";CV#(31);CV#(32);CV#(33);CV#(34);CV#(35);CV#(36);CV#
(37);CV#(38);CV#(39);CV#(40)
4920 PRINT
4930 PRINT "41";
4940 PRINT USING " ##.###";CV#(41);CV#(42);CV#(43);CV#(44);CV#(45);CV#(46);CV#
(47);CV#(48);CV#(49);CV#(50)
4950 PRINT
4960 PRINT "51";
4970 PRINT USING " ##.###";CV#(51);CV#(52);CV#(53);CV#(54);CV#(55);CV#(56);CV#
(57);CV#(58);CV#(59);CV#(60)
4980 PRINT
4990 PRINT "61";
5000 PRINT USING " ##.###";CV#(61);CV#(62);CV#(63);CV#(64);CV#(65);CV#(66);CV#
(67);CV#(68);CV#(69);CV#(70)
5010 PRINT
5020 PRINT "71";
5030 PRINT USING " ##.###";CV#(71);CV#(72);CV#(73);CV#(74);CV#(75);CV#(76);CV#
(77);CV#(78);CV#(79);CV#(80)
5040 PRINT
5050 PRINT "CELL AVERAGE = ";
5060 PRINT USING "##.###";CELLAVG#;
5070 PRINT " ** TOTAL AH CHG #1 = ";
5080 PRINT USING "###.##";TOTAL1.AH#;
5090 PRINT " ** TOTAL AH CHG #2 = ";
5100 PRINT USING "###.##";TOTAL2.AH#
5110 PRINT "HIGH CELLS ARE CELL NO. "; HC1N; " ";
5120 PRINT USING "##.###"; HC1#;
5130 PRINT " AND CELL NO. "; HC2N; " ";
5140 PRINT USING "##.###"; HC2#;
5150 PRINT "LOW CELLS ARE CELL NO. "; LC1N; " ";
5160 PRINT USING "##.###"; LC1#;
5170 PRINT " AND CELL NO. "; LC2N; " ";
5180 PRINT USING "##.###"; LC2#;
5190 PRINT "TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40 "; CHG1LAT; " FOR
CELLS 41 THRU 80 ";CHG2LAT
5200 PRINT "COMMANDED CURRENT CHARGER # 1 IS "; CHG.11#; " AMPS CHARGER
# 2 IS "; CHG.12#; " AMPS"

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5210 PRINT " ACTUAL MEASURED CURRENT CHARGER # 1 ";
5220 PRINT USING "###.##"; CHG1.1M#;
5230 PRINT " AMPS"; " CHARGER # 2 ";
5240 PRINT USING "###.##"; CHG1.2M#;
5250 PRINT " AMPS"
5260 RETURN
5270 / ***** TOGGLE DISPLAY ON/OFF *****
5280 IF TOGG = 1 THEN 5300
5290 IF TOGG = 0 THEN 5310
5300 TOGG = 0 : GOTO 5320
5310 TOGG = 1
5320 RETURN
5330 /
5340 / ***** PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY *****
5350 /
5360 PRINT "CELL NUMBER " ; LOOP ; LCS ; " CELL VALUE IS";
5370 PRINT USING "###.###"; CELL.VALUE#
5380 PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL;
5390 PRINT " "; FS
5400 PRINT "CHARGER # 1 ";
5410 PRINT USING "###.##"; CHG1.1M#;
5420 PRINT " AMPS"; " CHARGER # 2 ";
5430 PRINT USING "###.##"; CHG1.2M#;
5440 PRINT " AMPS"
5450 PRINT "COMMANDED CURRENT CHARGER # 1 IS ";CHG.1I#; "AMPS CHARGER # 2
IS " ;CHG.12#;"AMPS"
5460 PRINT : PRINT
5470 FOR PRDL = 1 TO 2000 : NEXT
5480 RETURN
5490 /
5500 / ***** ADJUST CHG.1 FOR OUTPUT CURRENT CHANGES *****
5510 / *** CHARGER # 1 CURRENT CHANGE ONLY *****
5520 CHAN = 0 : GOSUB 2080 : RETURN
5530 / *** CHARGER # 2 CURRENT CHANGE ONLY *****
5540 CHAN = 1 : GOSUB 2080 : RETURN
5550 / *** CHANGE CURRENT ON BOTH CHARGERS *****
5560 GOSUB 5510 : GOSUB 5530 : RETURN
5570 /
5580 / ***** DISPLAY MEASURED CURRENT *****
5590 FOR CC = 1 TO 5
5600 GOSUB 2980 ' GET CHG1.1M# AND CHG1.2M#
5610 PRINT "CHARGER # 1 ";
5620 PRINT USING "###.##"; CHG1.1M#;
5630 PRINT " AMPS"; " CHARGER # 2 ";
5640 PRINT USING "###.##"; CHG1.2M#;
5650 PRINT " AMPS"
5660 PRINT : PRINT
5670 FOR CCO = 1 TO 1000 : NEXT
5680 NEXT
5690 PRINT "IS CURRENT MEASURED OK? (y,n)"
5700 CCQ$ = INPUT$(1)
5710 IF CCQ$ = "y" THEN RETURN
5720 IF CCQ$ = "n" THEN 5740
5730 GOTO 5690
5740 PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
5750 CCQ$ = INPUT$(1)
5760 IF CCQ$ = "y" THEN 5870
5770 IF CCQ$ = "n" THEN 5790
5780 GOTO 5740
5790 PRINT "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.1I# : PRINT
5800 PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
5810 INPUT CHG.1I#
5820 IF STCHG OR STCHG1 > 0 THEN 5840 '2 AMP RATE RELAY ENABLE SET
5830 GOTO 5850
5840 IF CHG.1I# > 2.5 THEN GOSUB 6590 : GOTO 5790
5850 CHG.1 = CHG.1I# * 255
5860 GOSUB 5510 : GOTO 5590
5870 PRINT "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.12# : PRINT
5880 PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
5890 INPUT CHG.12#
5900 IF STCHG OR STCHG2 > 0 THEN 5920 '2 AMP RATE RELAY ENABLE SET
5910 GOTO 5930
5920 IF CHG.12# > 2.2 THEN GOSUB 6590 : GOTO 5870
5930 CHG.1 = CHG.12# * 255
5940 GOSUB 5530 : GOTO 5590
5950 / ***** PRINT RELAY LATCH CONDITIONS *****
5960 PRINT
5970 PRINT " RELAY LATCH CONDITIONS ( 0 = OPEN 1 = CLOSED )" : PRINT
5980 PRINT " 1 2 3 4 5 6 7 8
9 10"
5990 PRINT : PRINT
6000 PRINT " ";CEVS(1);" ";CEVS(2);" ";CEVS(3);" ";CEVS(4);"
";CEVS(5);" ";CEVS(6);" ";CEVS(7);" ";CEVS(8);" ";CEVS(9);"
";CEVS(10)
6010 PRINT " ";CEVS(11);" ";CEVS(12);" ";CEVS(13);" ";CEVS(14)
";CEVS(15);" ";CEVS(16);" ";CEVS(17);" ";CEVS(18);" ";CEV
S(19);" ";CEVS(20)
6020 PRINT " ";CEVS(21);" ";CEVS(22);" ";CEVS(23);" ";CEVS(24)
";CEVS(25);" ";CEVS(26);" ";CEVS(27);" ";CEVS(28);" ";CEV
S(29);" ";CEVS(30)

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6030 PRINT " ";CEVS(31);" ";CEVS(32);" ";CEVS(33);" ";CEVS(34);
;" ";CEVS(35);" ";CEVS(36);" ";CEVS(37);" ";CEVS(38);" ";CEV
S(39);" ";CEVS(40)
6040 PRINT " ";CEVS(41);" ";CEVS(42);" ";CEVS(43);" ";CEVS(44);
;" ";CEVS(45);" ";CEVS(46);" ";CEVS(47);" ";CEVS(48);" ";CEV
S(49);" ";CEVS(50)
6050 PRINT " ";CEVS(51);" ";CEVS(52);" ";CEVS(53);" ";CEVS(54);
;" ";CEVS(55);" ";CEVS(56);" ";CEVS(57);" ";CEVS(58);" ";CEV
S(59);" ";CEVS(60)
6060 PRINT " ";CEVS(61);" ";CEVS(62);" ";CEVS(63);" ";CEVS(64);
;" ";CEVS(65);" ";CEVS(66);" ";CEVS(67);" ";CEVS(68);" ";CEV
S(69);" ";CEVS(70)
6070 PRINT " ";CEVS(71);" ";CEVS(72);" ";CEVS(73);" ";CEVS(74);
;" ";CEVS(75);" ";CEVS(76);" ";CEVS(77);" ";CEVS(78);" ";CEV
S(79);" ";CEVS(80)
6080 RETURN
6090 ' ***** SECURE AUDIO ALARM *****
6100 DPORT = 1 : DWORD = 0
6110 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
6120 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
6130 RETURN
6140 '
6150 ' ***** COMPUTE CELL AVERAGE *****
6160 CELLAVG# = 0 : TOTCELL.VAL# = 0
6170 FOR CA = 1 TO 80
6180 TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
6190 NEXT
6200 CELLAVG# = TOTCELL.VAL# / 72
6210 RETURN
6220 ' ***** print test cell and return to stop *****
6230 PRINT "cell number "; LOOP;" is ";
6240 PRINT USING "#.###"; CELL.VALUE#;
6250 PRINT " volts"
6260 RETURN
6270 '***** OUTPUT PULSE TO RESET COUNTERS AND MONITOR CIRCUIT *****
6280 DPORT = 0
6290 GOSUB 3140 'GOSUB DIGITAL I/O PREPARATION
6300 DWORD = 8
6310 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
6320 DWORD = 0
6330 GOSUB 3210 'GOSUB DIGITAL I/O OUTPUT
6340 GOSUB 2270 'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
6350 RETURN
6360 ' *** record cevs totals for both chargers and tot.cell *****
6370 TOT.CELL = 0 : CHG1LAT = 0 : CHG2LAT = 0
6380 FOR CLTS = 1 TO 40
6390 IF CEVS(CLTS) = 1 THEN 6410 ' SUM LATCHED CELLS FOR CHG #1
6400 GOTO 6420
6410 CHG1LAT = CHG1LAT + 1
6420 NEXT
6430 FOR CLTS = 41 TO 80
6440 IF CEVS(CLTS) = 1 THEN 6460 ' SUM LATCHED CELLS FOR CHG #2
6450 GOTO 6470
6460 CHG2LAT = CHG2LAT + 1
6470 NEXT
6480 IF CHG1LAT >= 38 THEN CHG1LAT = 0 : FS = " ***** 95% OF FIRST 40 L
ATCHED ***** : GOSUB 4520 ' SECURE CHG #1 AND OPEN RELAYS 1-40
6490 IF CHG2LAT >= 38 THEN CHG2LAT = 0 : FS = " ***** 95% OF LAST 40 LA
TCHED ***** : GOSUB 4650 ' SECURE CHG #2 AND OPEN RELAYS 41-80
6500 RETURN
6510 ' ***** SET HC1# TO CV#(LOOP) *****
6520 HC1# = CV#(LOOP)
6530 HC1N = LOOP
6540 RETURN
6550 ' ***** SET HC2# TO CV#(LOOP) *****
6560 HC2# = CV#(LOOP)
6570 HC2N = LOOP
6580 RETURN
6590 '***** ALERT OPERATOR TO SET CURRENT BELOW 2.2 AMPS *****
6600 PRINT
6610 PRINT "RELAY ENABLE IS SET FOR THE CELLS AFFECTED BY THIS CHARGER !!"
6620 PRINT : PRINT " ***** 2 AMPS OR LESS *****"
6630 PRINT : PRINT " PRESS ANY KEY TO CONTINUE "
6640 CONTINUE$ = INPUT$(1)
6650 RETURN
6660 ' ***** SECURE CHARGER ON LOW CELL DETECT *****
6670 IF LOOP < 41 THEN GOSUB 4520 : GOTO 6690
6680 GOSUB 4650 'SECURE CHARGER #2 AND LAST 40 RELAYS
6690 RETURN
6700 '***** SECURE CHARGER NO. 1, NO CHARGER CURRENT *****
6710 FS = ***** NO CHARGER CURRENT WITH RELAY ENABLE SET ON CHARGER NO. 1 **
** : GOSUB 4520 : STCHG = 0 : STCHG1 = 0
6720 RETURN
6730 '***** SECURE CHARGER NO. 2, NO CHARGER CURRENT *****
6740 FS = ***** NO CHARGER CURRENT WITH RELAY ENABLE SET ON CHARGER NO. 2 **
** : GOSUB 4650 : STCHG = 0 : STCHG2 = 0
6750 RETURN
6760 '*** CHECK IF LOOP ON 1-40 OR 41-80 THEN SECURE APPLICABLE CHARGER ***
6770 IF LOOP < 41 THEN GOSUB 4520 : RETURN
6780 GOSUB 4650

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6790 RETURN
6800 ' ***** SET HIGH CELL (LC1#) TO CV#(LOOP) *****
6810 LC1# = CV#(LOOP)
6820 LC1N = LOOP
6830 RETURN
6840 ' ***** SET LOW CELL (LC2#) TO CV#(LOOP) *****
6850 LC2# = CV#(LOOP)
6860 LC2N = LOOP
6870 RETURN
6880 ' ***** SET CELL ENABLE VOLTAGE RELAY LATCH (CEVS) *****
6890 PRINT "RELAY CELL NUMBER ?"
6900 INPUT CN
6910 CEVS(CN) = 1
6920 PRINT "INPUT RELAY CELL NUMBER? (y,n)"
6930 RCVS$ = INPUT$(1)
6940 IF RCVS$ = "y" THEN GOTO 6880
6950 IF RCVS$ = "n" THEN RETURN
6960 GOTO 6920
6970 ' ***** STORE AMP-HOURS OUT TO HARD DISC *****
6980 PRINT "INPUT AMP-HOURS FROM BATTERY DISCHARGE"
6990 INPUT AMPHOUR
7000 OPEN "A", #1, "TEMP1"
7010 PRINT#1, : PRINT#1, : PRINT#1,
7020 PRINT#1, TIMES; " DATE "; DATES 'ANNOTATE TIME AND DATE
7030 PRINT#1, : PRINT#1,
7040 PRINT#1, : PRINT#1,
7050 PRINT#1, " ***** AMP HOURS OUT SINCE LAST CHARGE IS ";
7060 PRINT#1, AMPHOUR; " ***** 'PRINT AMPHOUR FROM DISCHARGE
7070 PRINT#1, : PRINT#1,
7080 CLOSE#1
7090 RETURN
7100 ' ***** SET PREDECTIME# FOR AMPHOUR SUMS AT START OF CURRENT COMMAND ***
7110 GOSUB 7240 ' RETURNS VASLUE FOR TIME (DECTIME#); IN HOURS
7120 DECTIMESTART# = DECTIME#
7130 PREVDECTIME# = DECTIME#-1/3600
7140 RETURN
7150 ' ***** SUM THE TOTAL AMP-HOURS TOTAL1.AH# AND TOTAL2.AH# *****
7160 GOSUB 7240
7170 DELTATIME# = DECTIME# - PREVDECTIME#
7180 DELTA1.AH# = CHG1.1M# * DELTATIME#
7190 DELTA2.AH# = CHG1.2M# * DELTATIME#
7200 TOTAL1.AH# = TOTAL1.AH# + DELTA1.AH#
7210 TOTAL2.AH# = TOTAL2.AH# + DELTA2.AH#
7220 PREVDECTIME# = DECTIME#
7230 RETURN
7240 ' ***** GET DECIMAL TIME (DECTIME#); IN HOURS *****
7250 HR = VAL(MID$(TIMES,1,2))
7260 MIN# = VAL(MID$(TIMES,4,2))/60
7270 SEC# = VAL(MID$(TIMES,7,2))/3600
7280 DECTIME# = HR + MIN# + SEC#
7290 RETURN

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